# SILICON CHIP

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# Publisher's Letter

## Australia's energy policies should rely heavily on natural gas

The recent rise in the cost of petrol and diesel shows just how exposed Australia is to the world price for oil. Oil and petrol imports are surging as Australia's local oil fields dry up. The latest figures indicate that the nation's crude oil production has dropped by 44%, to the point where we are now producing 60-65% of what we consume. Predictably, there are screams from all affected users, asking for the excise to be reduced, for subsidies to promote the use of ethanol or LPG and so on. All of which ignores the fact that Australian petrol is about the fourth cheapest among developed nations.

In truth, this problem has been coming for a long time and will only continue to get much worse as nations like China and India ramp up their economic development and their consumption of energy. So what should we do to cope with the rising cost of petrol? Most people are already doing it – using their cars less or buying smaller, more fuel-efficient cars. This is the market economy in action! Hybrid (petrol or diesel + electric) vehicles don't really come into the picture for most people because they are simply too expensive compared to their petrol-driven equivalents.

Clearly, the Federal government's plan to subsidise the cost of LPG conversions for cars will do very little. Even if 50,000 drivers a year were able to convert to LPG, it would still only benefit a minority of motorists. LPG (liquefied petroleum gas) is also a limited resource, as it is a byproduct of oil refining. In the short term, most drivers are going to have to bear the pain of paying more.

In the long term, the solution to Australia's road transport fuel costs is the same as for our electricity generation – a move to natural gas. We have enormous reserves of natural gas and rather than selling it all to China, Japan, etc, we should be using more of it at home. Apart from its greatly reduced cost, natural gas-powered vehicles have almost the same fuel efficiency as for petrol and diesel. Nor is the conversion to CNG (compressed natural gas) much different to that for LPG. In fact CNG-powered vehicles are already available in the USA. If the USA can do it, why can't we? In fact, some CNG-powered buses have been used in Australia since 1994.

Another advantage for CNG is that it can be easily made available throughout the major cities of Australia – the pipelines are already in place. All the government has to do is to mandate that all vehicles sold in the future must have the option of being powered by CNG.

Clearly, while most people want to escape the prospect of higher petrol prices, there is no ready and cheap alternative, whether it is electric, hybrid, more public transport or whatever. In the long run, there is a fair chance that your future vehicle will be CNG-powered.

## Entries for Technology Awards closing soon

Entries for the above awards (see page 89) will close very soon, so if you or your school or university are thinking of entering, time is running out. In fact we are extending the deadline by two weeks to October 16th. The winners will be announced in the December 2006 issue. Entry requirements are as follows:

(1) A description of the project in no more than 1000 words.
(2) Full circuit and wiring diagrams, performance plots, etc.
(3) Good quality photographs to show all visual aspects of the project.
(4) Details of software.

Get your entries in now! You or your school could be the winners!

**Leo Simpson**

# Powerful enough to detect interest.

**Wade Barker**
***Navy Electronic Technician***

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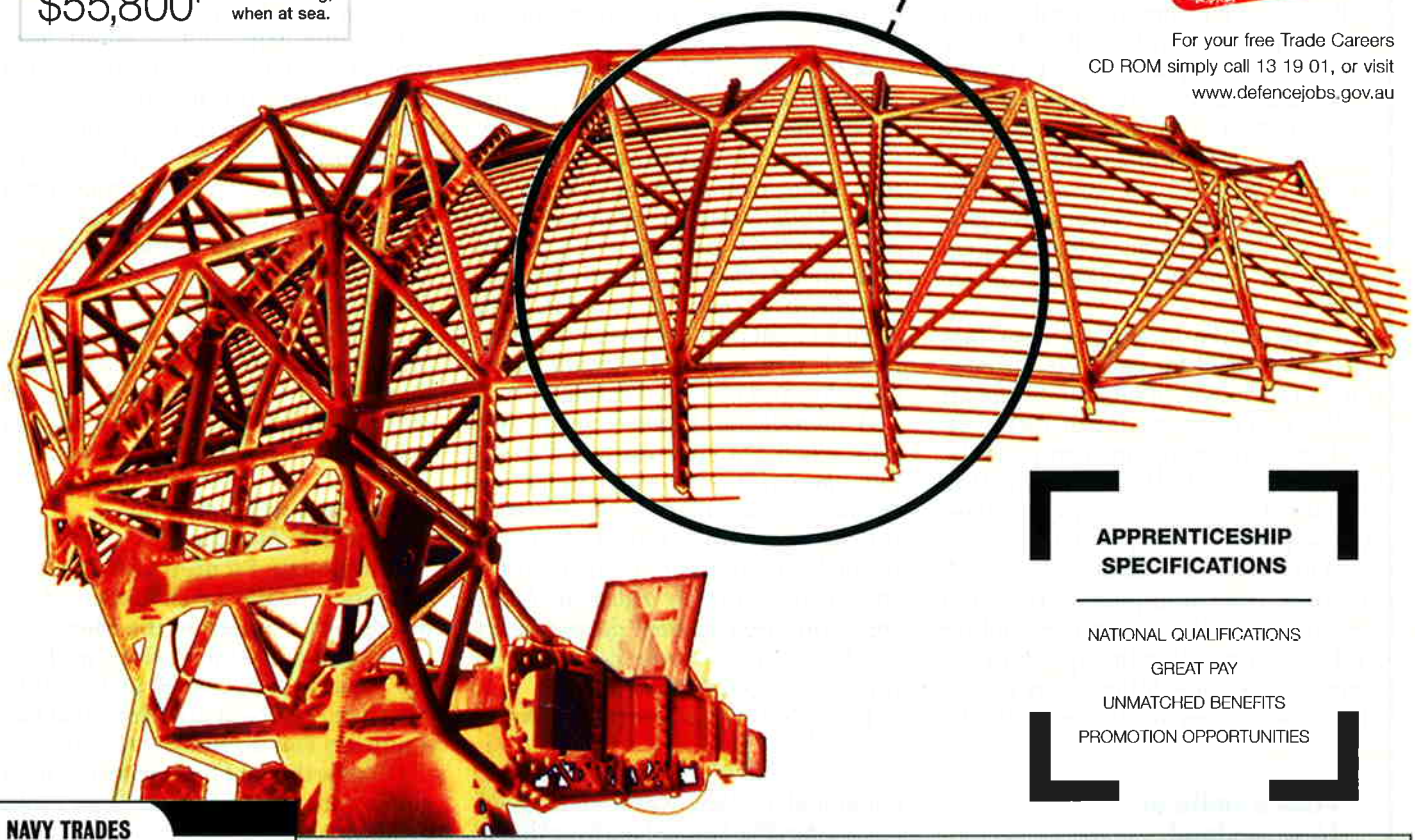

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# MAILBAG

## Time for a new battery charger design

I would like to suggest that it is time for SILICON CHIP magazine to revisit the subject of battery chargers for AA and AAA NiMH cells.

For a few years now, I have understood that the accepted wisdom for detecting full charge (and therefore to know when to stop charging) was the delta-V phenomenon. Manufacturers of commercial units seem to be under the same impression. So it was a bit of a shock to read on page 109 of the April 2006 issue ". . . we don't recommend –dV charge termination for the latest high-capacity NiMH cells. A safer method ...would be dT/dt". Indeed?

So here we go again on a new generation of battery chargers. Like many of your readers, I make much use of NiMH cells and I am surrounded by battery chargers of various designs, costs and performance. None of them gives me safe set-and-forget operation.

I would like to suggest then that there is a need for two new designs. One of them would be state-of-the art with dT/dt detection, full of microcontrollers, surface-mount components, flashing lights, and bells and whistles. It would be time-consuming to assemble, expensive to buy and not for me.

While that was being developed, perhaps you could publish the one I want. It would be a "retro" model for 1-4 cells, providing the option of automatic discharge followed by charge for a period set by the user in the light of experience and controlled by a simple analog timer accurate to plus or minus half an hour. It would use cheap non-critical parts, be available as a kit and easy for a senior citizen to assemble. Please?

**John Neate,**
**via email.**

*Comment: After extensive workshop tests on a variety of high-capacity AA and AAA NiMH cells, we have found that the use of -dV end-of-charge detection methods reduces longevity. In fact, some unbranded cells self-destructed (internally shorted) when charged at the 1C rate more than a few times.*

*Battery theory tells us that the negative dip in terminal voltage occurs after the cell has accepted all of the charge that it can at the current rate, meaning that some overcharging always occurs. While Nicad cells tolerate short over-charging periods well, NiMH cells do not. This is primarily because the chemical reaction in NiMH cells releases heat over the entire charging period, rising sharply during overcharging and causing venting.*

*A complicating factor comes into play when the cells are used in series (the norm). The slight difference between cells causes some to reach full charge before others, with the result being one of more cells in the stack being seriously overheated. The same situation applies during heavy discharge, where some cells may be reverse charged as well.*

*We note that some manufacturers have recently released "15-minute" fast-charge cells and matching chargers. We have not tested these devices but according to one manufacturer, "Rayovac's I-C3 technology used in the 15-Minute Rechargeable System allows unsurpassed charging speed due to the system's ability to control the internal cell pressure".*

*Unfortunately, only a small fraction of NiMH cells on the market appear to have this inbuilt protection mechanism, so we believe that a universal fast-charger for NiMH cells (in kit form) is not a viable proposition – at least at present. You'd be better off purchasing one of the 15-minute chargers with batteries (such as the DSE S-4421 or S-4423).*

*Alternatively, look for a fast-charger that charges cells individually, rather than in a stack. Failing that, stick to the old timed 15-hour trickle-charging cabinet, as sold in supermarkets.*

## Edison radio in New Zealand

I thought this comment might be worth adding to your excellent Vintage radio column from May 2006 on the Edison radio.

You mention A. R. Harris of Christchurch, as being the importer of this radio in 1930. Ambrose Harris was an employee of Thomas Edison in America in the very early part of the 20th century and when he emigrated to New Zealand a few years later, Thomas Edison awarded him the agencies in New Zealand for Edison products and Ambrose Harris set up in NZ an electrical equipment supply company and some of their products were Edison items. Until about 15 years ago, A. R. Harris was still owned by the Harris family.

**Matthew Thomas,**
**via email.**

## Bigger box needed for Battery Zapper

Just thought I'd drop you a note to comment on the latest Battery Zapper project featured in the May 2006 issue. The project may work well but the construction base is just woeful! That huge PC board in such a small box – how do you service the thing?

I'd have thought that projects which suffer from the Playmaster Twin 25/40 syndrome would have gone the way of the dodo by now. What's Twin 25 syndrome you may ask? Well it's a project that has to be totally disassembled to service it. Slicing that enormous PC board of the Playmaster Twin 25 amplifier with a jig saw and remounting things certainly made what should have been a simple task like changing an output transistor so much easier in that project.

Please, when a project is designed,

### Philo Farnsworth was father of TV

Thank you for your series on TV in Australia.

In the June 2006 article, on page 18, mention is made that "the title inventor of television is shared by many but if any one person deserves the credit, it is Vladimir Zworykin who developed the cathode-ray tube system".

Coincidentally, a brief obituary was published in the Wellington newspaper "The Dominion Post" in June 2006, for Elma Farnsworth, wife of television pioneer Philo Farnsworth.

The article mentioned that she "fought for decades to assure his place in history after his 1971 death" and that "it was Mr Farnsworth's work that led to the electronic TV we know today." This could be covered by the SILICON CHIP article when it suggests that the title is shared by many but the obituary goes on to say that "credit for the invention nearly escaped Farnsworth after RCA claimed the innovation was the work of its chief television engineer, Vladimir Zworykin. In 1935, the courts ruled on Farnsworth's patent, naming him TV's undisputed father".

Incidentally, Philo Farnsworth gave his wife equal credit for the invention, presumably because it is said that she helped him develop television, as she worked by her husband's side in his laboratories.

**Bill Cousins,**
**Blenheim, New Zealand.**

make sure that you can get to the PC board easily for service. If you can't, knock it on the head and use a bigger box. My Zapper needs checking as some smoke came out of the components when I connected it to a battery that wasn't well and it will definitely NOT be going back in that tidgy little box!

**Brad Sheargold,**
**via email.**

*Comment: what sacrilege – cutting up a Twin 25 PC board! Do you know how many hours it took to design that PC board and get everything on to it? It was designed that way to minimise wiring (compared to earlier designs which had multiple boards), making it cheaper, etc.*

*The same approach has been taken with the Zapper to try to keep the costs down. If you use a bigger box, the kit becomes quite a bit more expensive. Yes it does make things harder to repair but luckily, most readers build something, it works and that is the end of the story.*

*Anyway, you must have been a bit careless to let smoke out – how can an unwell battery damage it? It is supposed to work with unwell batteries!*

### Circuit of Murray amplifier wanted

I am writing to ask if any readers can help me locate technical information and/or a schematic of a commercially-built audio amplifier, 2-channel, 100W, 2U rack-mount, all balanced in/out with only Cannon connectors on the rear panel. It is called a Murray MA534 transconductance amplifier and is fitted with two toroidal output transformers to drive 100V lines.

Murray Amplifiers of Eastwood, NSW, made it and I am guessing around 1980-1985 but it may have been earlier.

I have had no success with my own research but there must be someone who knew of Murray's work and can shed some light in my direction.

**James Bonnefin,**
**Warners Bay, NSW.**

### Extra background on TV history

I have been reading the current series on Australian Television, with a great deal of interest, especially since I was "there" for most of it. My comments relate mainly to page 18 of the July 2006 issue.

The view of the GTV9 Siemens transmitter is most likely the vestigial sideband filter and the sound/vision combiner "plumbing"; no bites there! Band three transmitters in Australia were nominally 10kW with a gain of 10 in the antenna and feeders. GTV9 would have gone to air with 100kW ERP (Effective Radiated Power) unless


## Atmel's AVR, from JED in Australia

**JED has designed a range of single board computers and modules as a way of using the AVR without SMT board design**

The AVR570 module (above) is a way of using an ATmega128 CPU on a user base board without having to lay out the intricate, surface-mounted surrounds of the CPU, and then having to manufacture your board on an SMT robot line. Instead you simply layout a square for four 0.1" spaced socket strips and plug in our pre-tested module. The module has the crystal, resetter, AVR-ISP programming header (and an optional JTAG ICE pad), as well as programming signal switching. For a little extra, we load a DS1305 RTC, crystal and Li battery underneath, which uses SPI and port G.
See JED's www site for a datasheet.

### AVR573 Single Board Computer

This board uses the AVR570 module and adds 20 An./Dig. inputs, 12 FET outputs, LCD/Kbd, 2xRS232, 1xRS485, 1-Wire, power reg. etc. See www.jedmicro.com.au/avr.htm

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(like QTQ9 in Brisbane) they started transmissions on a temporary low gain antenna. Band one services generally were 20kW into an antenna with a gain of five.

The camera tube shown is a 4.5-inch image orthicon, most probably made by the English Electric Valve Co and used, among others, in the Marconi Mk4 and Mk5 cameras.

The controlling Government body for television was the Australian Broadcasting Control Board, not the PMG (Postmaster General) Department. Studio transmitter links were owned by the TV company and licensed by the PMG. No cable or diplexing of program bearers occurred. Later on, interstate bearers were provided by the PMG Department.

The National Television Service had programs provided by the Australian Broadcasting Commission who owned the studio equipment and the program conveyed to transmitters run by the PMG Department, Broadcasting Division via links installed and operated by that same PMG Division.

Many country TV stations used studio equipment, transmitter links and transmitters made by AWA in Sydney. All this is in the interest of an accurate record.

I have been a reader of SILICON CHIP since day one and congratulate you on maintaining a very high standard while others have lost their way.

**Brian Rickaby,**
**via email.**

## Hydrogen is not explosive

On page 16 of the May 2006 issue, in Jim Rowe's Battery Zapper article, column one has a warning message box. Hydrogen gas on its own is not explosive. I have heard this myth from many TAFE teachers and technicians.

When a lead-acid cell is being charged, it produces both oxygen and hydrogen in exactly the same proportions as in water. Normal charging keeps the oxygen and hydrogen in solution. If the charging voltage is sufficiently high, the water dissociates, releasing the gases which can then recombine explosively if given some ignition.

"Gassing" occurs when the cell Voltage exceeds about 2.6V. I say "about" because gassing depends on the chemical make-up of the plates, electrolyte temperature and how well heat can be dissipated – charging is not 100% efficient. If the charging voltage per cell is kept below about 2.4V, hydrogen and oxygen stay in solution and do not gas off.

The actual gassing voltage is temperature-related – as temperature rises, the gassing voltage falls; so, untended charging from unregulated chargers can result in rapid dehydration, third level sulfation and total ruin of the battery.

Arcing at the terminals of a lead acid battery is not usually a problem unless the battery is gassing. Some people mistakenly remove the cell caps to allow freer escape of gases – but the caps are usually designed to prevent a flame front from entering the cell. However, very high load current will always result in raising the electrolyte temperature and if continued, even boiling of the electrolyte. At such point, expansion and buckling of plates, internal shorting, runaway heating and explosion is a real possibility.

**Brian Clarke,**
**via email.**

*Comment: hydrogen by itself is not explosive but once it is emitted from the battery it can lead to the conditions for an explosion. There is also more chance of arcing occurring when the Zapper is in use because it generates high voltage pulses.*

*We do not advocate removing the battery caps.*

## Colour Day/Night cameras not sensitive to IR

I purchased a Samsung SVD-4120A colour day/night camera some time ago because of a vandalism problem at my house.

After installing the unit, I discovered that the night-time lighting levels were not enough to give a reasonable B&W image. There is a street light across the road but the image was very grainy – the position of the street light caused shadowing and there was not enough detail to allow identification of the culprits. Unfortunately, at the time I was very busy and did not have time to install IR illuminators to assist in boosting the night-time lighting levels.

Recently, I managed to install two illuminators only to discover they made no difference. I had assistance from a friend who installs a lot of CCTV systems and we both have security installer's licenses. Initially, we both assumed there was a voltage drop problem and that the illuminators had low output. However, increasing the voltage to the units made no difference.

After some navel pondering I asked my friend from whom I also sourced the camera to check if the camera was capable of detecting the 850nm IR light frequency. He asked the vendor the question. They had to do some research only to discover that the camera has built-in filtering that blocks IR light and there is no option to turn off the filtering!

My point is that camera manufacturers MUST supply the light frequency spectrum of which the cameras are capable of receiving so that installers can make informed decisions regarding the products they purchase and install.

None of the data sheets for the cameras I've installed provide this information. I've only ever seen this information provided with those cameras the incorporate illuminators in the camera body.

So don't assume day/night cameras are IR-compatible. Always ask before you buy. Minimum standards need to be invoked to ensure that the manufacturers of such equipment provide relevant information.

**Mal Land,**
**Frenchs Forest, NSW.**

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SHORE AD/MGRM1006

7

ment on the request by P. W. for a 10-level tank gauge on page 122 of the August 2006 issue.

The classic solution to tank water gauging is a DP cell (differential pressure capsule) transmitter with 4-20mA output. These allow very accurate analog readings, even in pressurised and unpressurised tanks. The units are very expensive except for industrial purposes where they last for years.

Assuming you want a "do it yourself" hobby type application, the cheapest incremental method by far is based on the good conductivity of potable water. By implication I assume that P. W. means drinking water or at least rain water?

This utilises a number of 6mm diameter stainless steel rods, threaded for an appropriate length at one end. The number and length of rods determines the increments plus a full-length "earthing" rod, essential in plastic tanks.

Suitably mounted into a disc of good insulating material of say 200mm diameter with stainless steel nuts, washers and solderable tags, one can easily build a tank head sensing unit giving say 10% increments. Visualise the rods hanging vertically down in a circle of ever decreasing lengths. The electronics are simple, comprising suitable multi-Schmitt trigger ICs. A rod touching or immersed in water will present hundreds of ohms electrolytic conductivity (milliSiemens) while in air it is practically an open circuit (infinity). These two conditions trigger, respectively, an on or off condition, dependent on the Schmitt trigger hysteresis setting.

With little power requirements for LEDs, the electronics could be built into the tank head unit and multi-core telephone wire used to provide power and outputs to a remote LED unit.

Pity that P. W. didn't give tank size or material. I'll assume a plastic tank of 37,000 litres (37 cubic metres) and 2-metre radius. By simple calculation based on a cylinder, that would give a tank height of approximately 3m and this would require about 17m total of stainless steel rod.

Finally, if you only want to view the contents from a distance, the float, pulley/s, pointer and external scale is the traditional cheapest alternative if you don't mind "full" being indicated at the bottom of the scale. I had this for years when I lived in Western Australia!

Stating the obvious, the tank must have an outlet. What about a piece of clear plastic hose up the tank side with a scale? A sight glass no less! Now that really is basic!

**Robert Gott, West Yorkshire, UK.**

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## 3-core flex is the only legal earthing for appliances

I have just read the article by John Clarke in your July 2006 edition, concerning double-insulated equipment.

The idea might be good but it breaks the Wiring Rules applying to Earthing of Electrical Appliances. The AS/NZ 3000 Wiring Rules Section 5.7.3.1, Section C states that: "Earthing of electrical equipment supplied by flexible cord or flexible cable. The exposed conductive parts of electrical equipment supplied by flexible cord or cable shall be earthed by connection to a protective earthing conductor incorporated with the associated live conductors in the sheath, braid or enclosure of the supply cord or cable".

In other words, the lead on the portable appliance will have to be changed to a 3-core flex, not with a separate earth wire. This will then make the project legal.

**Dennis Seymour, Howick, New Zealand.**

*Comment: the difficulty with your argument is that strictly speaking, double-insulated appliances are not supposed to be earthed. So where does that leave us – having to put up with zaps? Your solution would probably also void any warranty.*

*Ultimately, we are of the opinion that appliances capable of giving shocks to users in the circumstances outlined in the article should not be approved as double-insulated. They should be earthed as you suggest but that's not going to happen, is it?*

## Congratulations on DVD production

Congratulations to John Wright and all involved in producing the Radio and Hobbies 1939-1965 DVD. This is a truly remarkable collection of both technical and social history. Since I received my copy, every spare moment has been spent browsing these long forgotten pages. I hope EA, ETI and the other publications owned by SILICON CHIP will also eventually appear on DVD.

**John Hassell, Perth, WA.** SC

# Turn an old XBOX into a $200 Multimedia Player

by Julian Edgar

**The Microsoft X-Box gaming console** has been replaced with the X-Box 360 . . . and that makes secondhand X-Boxes very cheap indeed.

And now you can fit a 'mod chip' that allows the X-Box to become a full multimedia centre – at a lower price than sourcing a used PC – and with an end result that looks far more at home in your lounge room, not to mention working seamlessly with your TV.

It's also possible to fit a large hard drive which will give you an almost endless source of multimedia entertainment.

There are several approaches that can be taken to X-Box modification.

One approach is to take your X-Box to a specialist who will fit the mod chip, load the new software, upgrade the hard drive capability and even convert the output to suit HD TVs.

At the other end of the spectrum, you can do it all yourself. However, you'll need to plough through lots of very geeky instructions from a number of web sources, do a very big web download and be familiar with open source software.

Doing it yourself also means it's possible to make big enough mistakes in the software installation to completely disable your X-Box.

We chose a middle road of buying and installing the mod chip and then having someone else install the software and configure it for our home PC network.

And since the X-Box was being used solely as an MP3 music player, we also kept the standard 8GB hard drive. If required, it can be upgraded later.

Overleaf, we show each step required – it's not hard to do as long as you're methodical.

## Features

- Cheap multimedia player
- Handles nearly every format of sound and video files
- Networks to your PC
- Plugs straight into your TV
- Expandable to large hard disc
- Free multimedia software
- Better looking in your lounge room than a PC!
- Infrared remote available

# X-BOX DISASSEMBLY

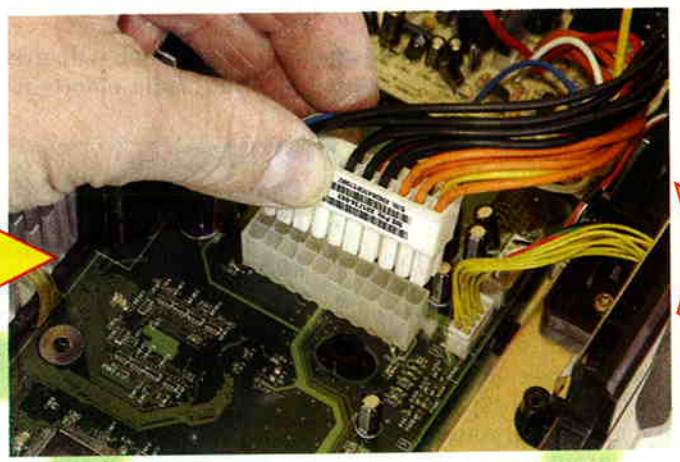
The first step is to undo the six Torx T10 screws that hold the case halves together. There's a screw under each of the feet (just peel them off to gain access) and two under labels.

With the top removed, you'll be able to see the DVD drive (left) and the hard drive (right). These must both be removed to gain access to the motherboard which lies beneath.

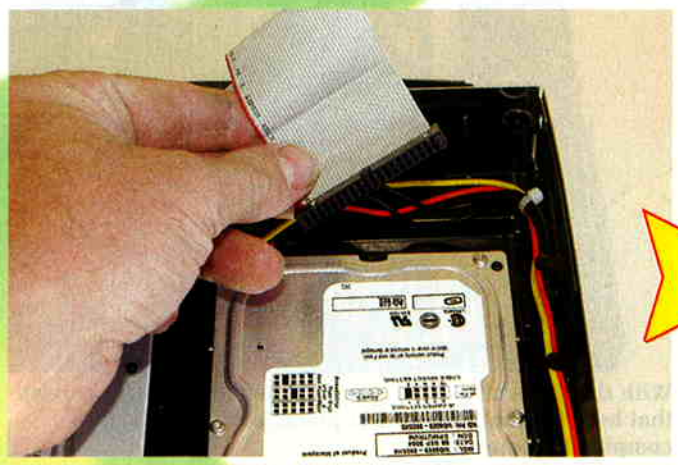
The HDD can then be lifted out and the power cable disconnected.

The next step is to remove the DVD drive. Disconnect the IDE cable...

You can now see the motherboard and power supply in all their glory.



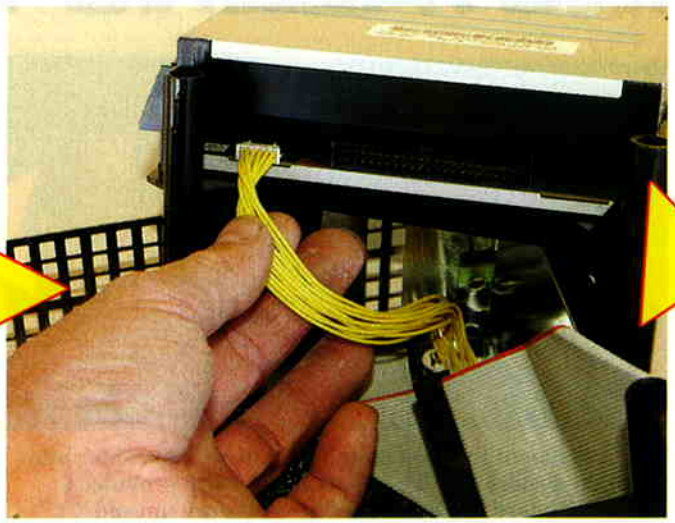
The motherboard needs to be removed so pull the power supply plug...



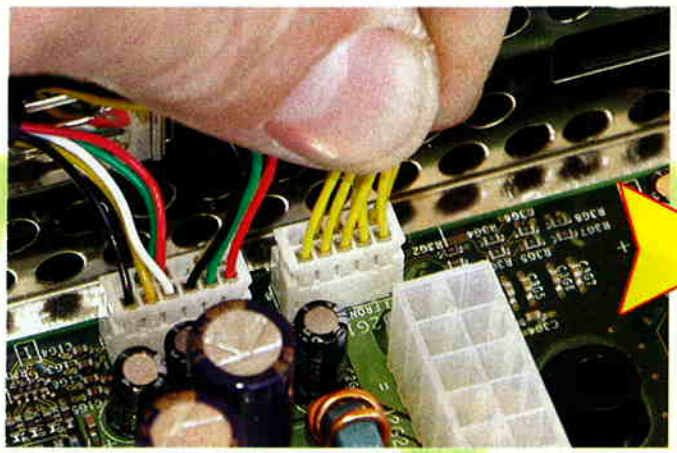
Remove the IDE cable from the back of the hard drive...

...and then use a T20 bit to remove this screw that holds the HDD plastic tray in place.

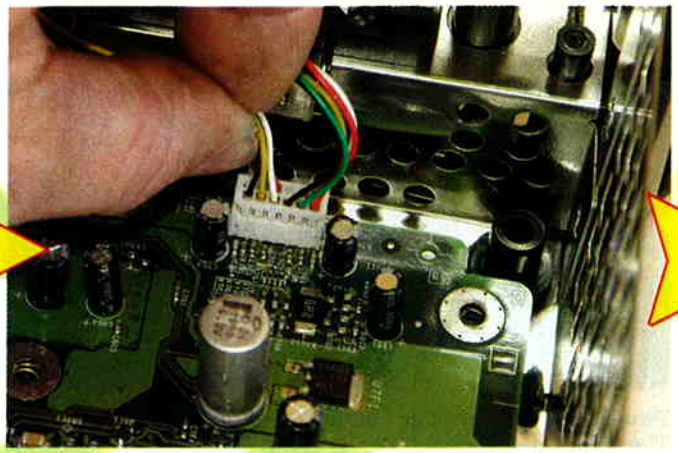
... and then use the T20 bit to undo this and another screw on the other side of the DVD drive.



The DVD drive can then be lifted out and its power cable disconnected.

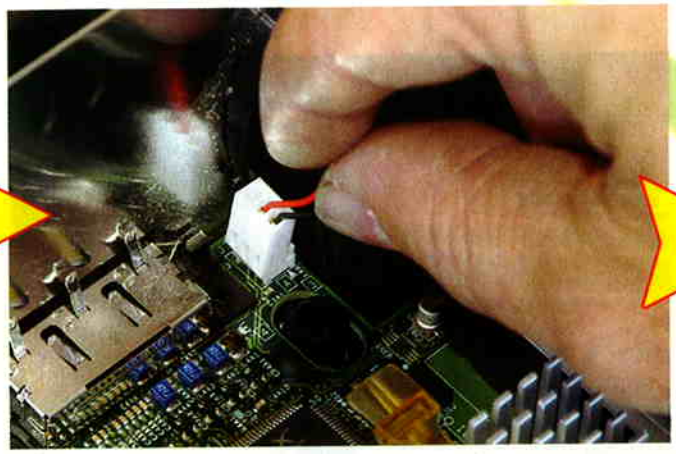


.. and these two connectors...

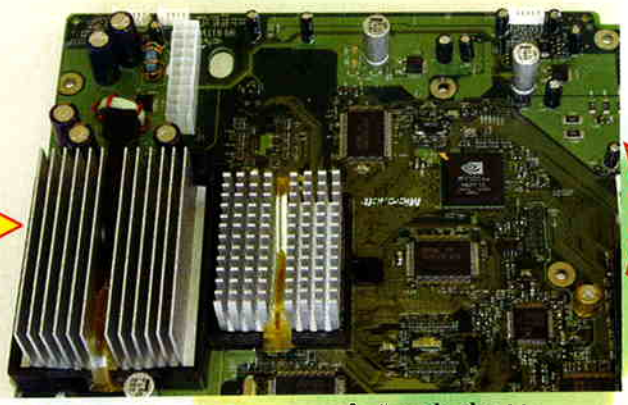


..and this one...

# X-BOX DISASSEMBLY . . . cont



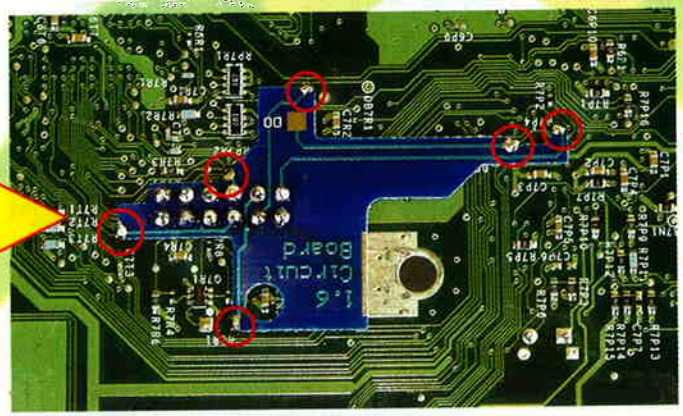
...and not forgetting the power feed to the fan.



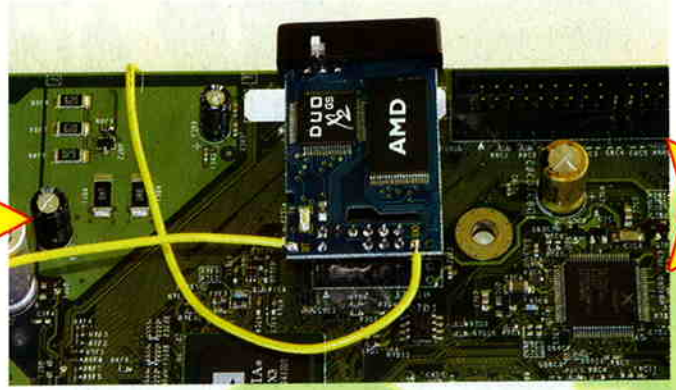
With the plugs all pulled, you can then undo the 11 screws that hold the motherboard in place, allowing it to be completely removed.

# INSTALLING THE MOD CHIP

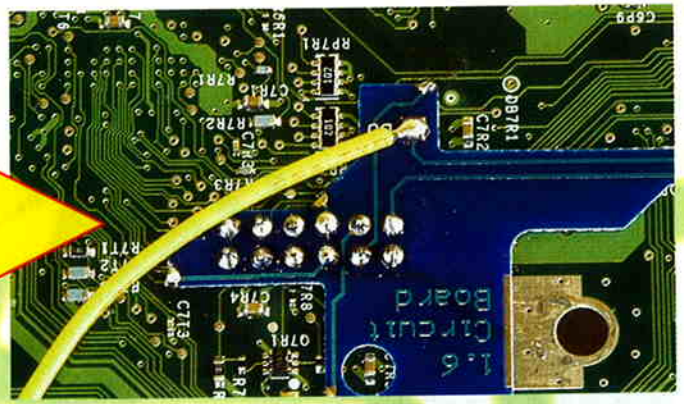
The first step in the mod chip installation is to solder into place the header pin. The holes are already provided on the PC board but note that four holes are unused. Kangamail has photo instructions on their web site, although they don't include installation of the daughter board (covered in a moment).



So that this daughter PC board can later be placed over the top, the header pins are soldered into place using only a little solder. In addition to being soldered to the header pins, the PC board is also soldered at the circled points. Pre-tinning these PC board pads should be done before the daughter PC board is placed on the main board.

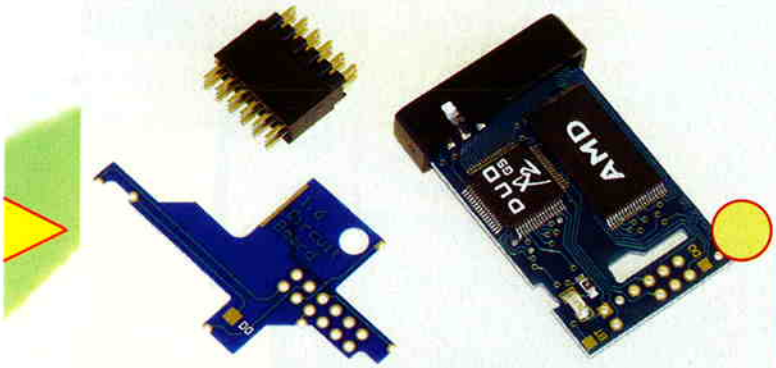


Two flying leads must be connected to the mod chip board. The solder pad marked 'DO' is connected to....



... the DO pad on the daughter board on the other side of the main PC board. This wire can wrap around the edge of the main PC board – there's plenty of clearance when the main PC board is back in the case.

# tinued




A variety of X-box modification chips is available. This one is the Duo-X 2, produced by www.duomodchip.com. It was purchased online from www.kangamail.com which is located in Australia. This mod chip suits all versions of the X-Box (see 'Which Version?' panel)

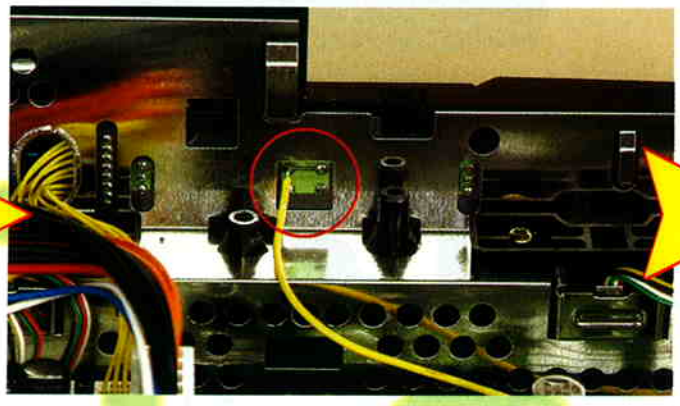
The modified X-Box working as a lounge room MP3 player. The XBMC software is shown displayed on the TV, with from the top of the equipment stack downwards: the X-Box, satellite TV receiver, DVD player, digital video recorder and amplifier. And to think I don't even watch much TV!

The mod chip board can then be soldered to the header pins. Note the two position switch (circled). Depending on the X-Box version, this switch must be in either this or its other position. In V1.6 X-Boxes, it should be in the other position.

## Remote Control

It's quite possible to completely operate the X-Box Media Center software using the games hand controller. However, as well as looking a bit clunky, it's a wired remote. But an infrared remote is available for the X-Box – it's usually called the DVD Remote.

The receiver plugs into one of the front ports and the remote then operates like any other remote control. But note that in the overall cost of things, the remote and receiver are quite expensive – a no-name brand will set you back about $40 and the Microsoft one about $50. As always, a secondhand unit will be cheaper than buying new.



The BT pad on the mod chip is connected to this terminal on the back of the EJECT button. This connection is made when the main PC board has been reinstalled in the case.

The finished job, prior to the DVD and hard drives being reinstalled.

**The X-Box fits in neatly above the Austar receiver. Note the remote control receiver plugged into one of the front ports – a remote allows full operation of the X-Box in multimedia form.**

## Testing

With the mod chip installed, it's time to see if everything works as it should. Connect the X-Box to power, the AV leads to the TV and the hand controller to the X-Box. (Note: the following instructions refer to the Duo-X 2 mod chip and Version 1.6 X-Box – check the documentation for other mod chips and/or other X-Box versions.)

Power-up the X-Box by pressing the Eject button. The normal green star should appear on the TV screen with 'XBOX' in green beneath it and 'Microsoft' in smaller writing in white beneath that. Shut the system down by powering it off and then start it up again, this time by pressing the Power button.

This time an additional shield-shaped object should appear in the top-left corner with 'Evo X' written on it. Therefore, the X-Box can be booted in normal mode (by pressing Eject) or in mod chip mode (by pressing the Power button).

If the X-Box fails to boot, try the mod chip switch in the other position and check your soldering very carefully with a magnifying glass and strong light.

## Software Installation

As indicated earlier, we chose to take the modified X-Box to a third party to have the software installed and the network access set up.

The open source software is called XBMC (X-Box Media Center) and is freely available on the web – see http://www.xboxmediacenter.com/info_project.htm. The installation and network configuring took about 30 minutes.

The network set-up is fairly straightforward but if you're at all unsure of networking, follow the following sequence to obtain the information the software installation person will need about your system: On your PC go to Start, Run then type **cmd** and at the command prompt **ipconfig/all**.

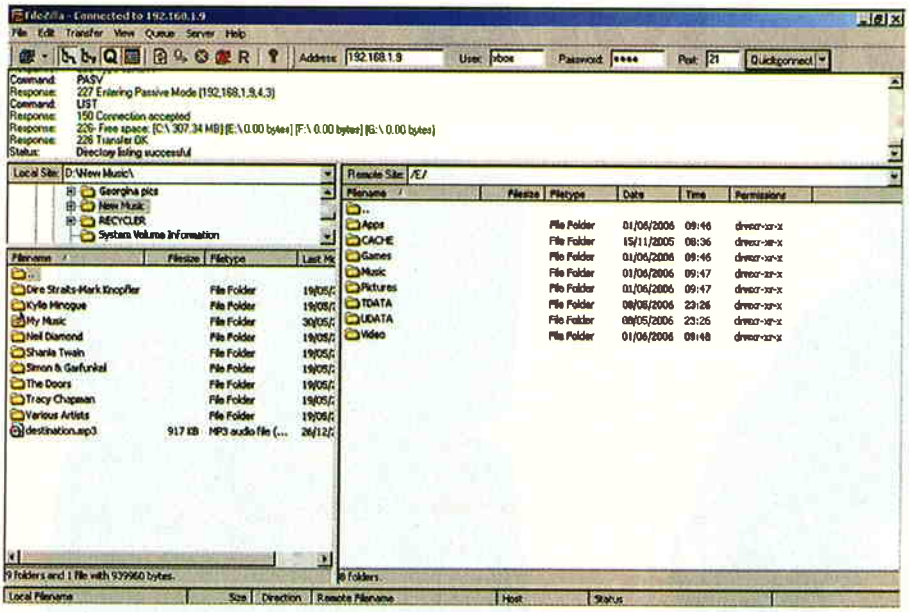
### Which Version X-Box?

Eight versions of the X-Box were produced. Identification of the version must be carried out if the correct mod chip is to be selected and installed. http://xbox-scene.com/versions_0.php gives a step by step guide to identifying the versions, starting with the externally accessible serial number and then moving inside the box.

**X-Boxes in excellent condition can now be bought for as little as $100. This one was purchased from a second-hand store for $120, complete with a 30-day warranty – an assurance it wouldn't be dead on arrival.**



siliconchip.com.au



**FTP software is needed to transfer files to the X-Box. At left is the local site (ie your PC) and at right is the remote site (ie the X-Box). Transferring files is as easy as clicking and dragging.**

Then print this screen to an image viewer (ie, press the Print Screen key and then paste it into the image viewer) and print it out. Take along (or send) this piece of paper with the X-Box.

It's important that you obtain the IP address for the X-Box from the person who sets up the network, otherwise you won't be able to send files to the X-Box. This assumes that – as with most households these days – you have a PC network set up in your home.

## File Transferring

To transfer files to the modified X-Box you'll need to use an FTP program and the X-Box will need to be connected to your computer network. FileZilla is freely available and works fine: go to http://prdownloads.sourceforge.net/filezilla/FileZilla_2_2_24a_setup.exe?download for the download.

To transfer files to the X-Box using this program, type the IP address of the X-Box in the 'Address' window, **xbox** into the User box and **xbox** into the password box.

When the program has successfully connected to the X-Box, text indicating success in connection will appear on FileZilla screen. Furthermore, the hard drive letters of the X-Box (eg C, D, E, F) will then appear in the Remote Site box.

Moving files is as simple as highlighting them in the Local Site box and clicking and dragging them across to the location you want them to be in the X-Box.

For example, that could be in /E/Music or /E/Video. Files can be deleted from the X-Box by right-clicking on them and selecting Delete.

Note that (of course!) the X-Box must be switched on from the start of this whole process!

## Using XBMC

There is a users' guide for XBMC at http://manual.xboxmediacenter.de/wakka.php?wakka=Index but as with the software installation, it's really designed for people heavily into computer software and hardware. In other words, it's incomplete, not particularly well written and should be best used only when you get stuck! (Note: that's the manual; the software itself works fine and is easy to use.)

As with most computer software, the quickest way of getting a feel for XBMC is to play with the hand controller. In five or 10 minutes you'll soon learn where the 'back' and 'select', 'fast forward' and 'rewind' keys are – we must admit that we didn't try too hard in this area because we almost straightaway went to the infrared remote, on which the keys are self explanatory (see the 'Remote Control' panel).

## Conclusion

As secondhand X-Boxes continue to fall in price taking this approach will become increasingly attractive. Already it can put a whole new world of entertainment in your lounge room!

## Costs

Cost will vary greatly on how well you bargain, whether you choose to fit a larger hard drive, whether you use the wired game controller or an infrared remote and so on. As a guide, this table shows the actual prices we paid: **SC**

| Item | Supplier | Cost |
|---|---|---|
| **X-Box with power cord, hand controller and AV leads** | Cash Converters, Runaway Bay, Gold Coast, Queensland | $120 |
| **X-Box infrared remote and receiver** | Cash Converters, Toowoomba, Queensland | $25 |
| **Duo-X 2 Mod Chip** | www.kangamail.com - supplier http://www.duomodchip.com/english/install.htm - support | $35 including freight |
| **XBMC software supply and install** | www.mod-store.com.au Gold Coast: 0422 450 665 | $30 |
| **Cat 5E network cable** | Harvey Norman, Arundel, Gold Coast, Queensland | $15 |
| **FTP client software** | http://prdownloads.sourceforge.net/filezilla/FileZilla_2_2_24a_setup.exe?download | Free |
| | **Total** | **$225** |

# BENCHMARK Sept 2006

DICK SMITH ELECTRONICS

**4.8V Rechargeable Cordless Screwdriver**

Great for jobs around your home or office, this 4.8V rechargeable cordless screwdriver uses a durable metal gearbox and strong moulded body for longer life. Forward/reverse control, 3-4hr mains charger, accessory bits and instructions. **T 4844**

**$19.99**

**2 YEAR WARRANTY**

DSE

**40-Piece Hobby Rotary Tool Kit**

Able to cut, drill, polish, grind, sand, engrave. Includes blow mould storage case, pencil grip rotary extension attachment, collets, grinder, engraver, sander, drill, buffing attachments, plus more! **T 4823**

**$29.99**

DSE

**Variable Length Mini-Bit Screwdriver**

5pcs bits are held inside the screwdriver body in a rotary holder, handy adjustable shaft feature (55mm to 110mm long), total of 6pcs mini-size bits supplied. **T 6335**

**$8.65**

DSE

**'Bit Shooter' Adjustable Bit Screwdriver**

Changing the bit in your screwdriver is now even easier. Holds the 12 supplied screwdriver bits in 2 slip-in rotary holsters that allow simple selection and loading into the tip of the screwdriver via a pump action of the screwdriver handle. **T 6329**

**$8.99**

**SAVE $6**

iroda.

**PRO-IRODA PT-200 Butane Torch**

A heavy duty butane blowtorch that provides a powerful wind resistant adjustable flame with temperatures up to 1300°C. Uses waterproof piezo electronic ignition with a child-resistant safety system. The large polymer storage tank can provide up to 60 minutes of continuous operation and is easily refilled with standard butane gas. Internal brass and ceramic parts ensure precise operation. **T 1101**

**$29.99**

**SAVE $10**

**Lead-Free Solder**

1mm diameter, 99.3% tin, 0.7% copper. Flux cored. 100g roll. **N 2630**

**$7.98**

**5mm White 2000mcd LED**

4.0V @ 30mA. **Z 3980**

**99¢**

**SAVE 49%**

**'Cyclops' Hi-Power 1W Red LED**

2.2V DC 350mA 30 lumens. High luminous flux, long operating life of up to 100,000hrs. Requires heatsinking and a constant current source. Includes data. **Z 4251**

**$4.99**

**SAVE 50%**



DICK SMITH ELECTRONICS

Products also available through www.dse.com.au

# Look what's HOT!

100W for fast heat-up!

DICK SMITH ELECTRONICS

### 100W Precision Soldering Station

This precision soldering station provides huge 100W power for fast heat-up and recovery while maintaining tip temperature within +/- 3°C. Ideal for use with lead-free solder, this high power soldering station uses a lightweight soldering pencil with a ceramic heater element and integral temperature sensor for fast heat-up and temperature control responses. It's supplied with a plated and pre-tinned 1.6mm tip and uses burn-resistant cable between the soldering pencil and the soldering station for added safety. An in-built Energy Saver circuit extends tip life by cutting power consumption in half if the station has been idle for 15 mins, with the slightest motion of the soldering pencil activating the heater and very quickly returning the tip to its preset temperature. For added safety, the heater element is isolated from the mains by a 32V AC output transformer, and zero-voltage switching is used to help protect any sensitive circuitry you may be working on. The tip temperature is adjustable between approx 200°C and 450°C, and a bright LED display clearly shows the current temperature in either °C or °F. Supplied complete with a soldering iron stand and spiral brass tip cleaner.

T 2260

**$199**

DICK SMITH ELECTRONICS

### Ultrasonic Tape Measure with Laser Pointer

Make distance, volume and area calculations quickly and easily with this ultrasonic tape measure. It provides a measurement range of 0.6m to 15m, a 5 digit LCD screen and uses an in-built low-power class II laser marker to indicate the item you are measuring. Operates on a 9V battery.

Q 1507

**$49.94**

DICK SMITH ELECTRONICS

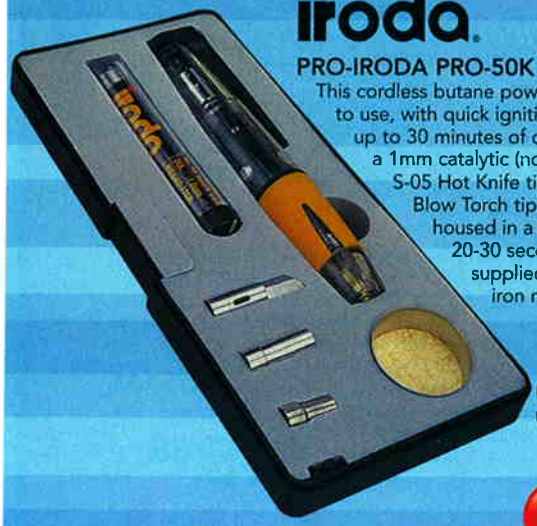
### 3.5 Digit LCR Multimeter

Measures inductance, capacitance, frequency, resistance and AC/DC currents and volts. Also tests transistors, continuity and diodes. Other handy features include a 2000 count LCD screen, auto power off, low battery warning and an over-range indication. Comes complete with test leads and holster.

Q 1559

**$69.99**

SAVE $30




### PRO-IRODA PRO-50K Solderpro Kit

This cordless butane powered soldering iron kit is simple to use, with quick ignition and an internal tank that provides up to 30 minutes of operation at mid-setting. Supplied with a 1mm catalytic (no flame) soldering iron tip, as well as an S-05 Hot Knife tip, S-07 Hot Blower tip, pin-point S-06 Blow Torch tip, as well as a tip cleaning sponge, all housed in a black plastic case. Ready to use just 20-30 seconds after ignition. Butane gas not supplied. NB. Colour of soldering iron may vary. T 1103

**$49.98**

SAVE $10

### 25-Drawer Parts Cabinet

Stores all your components, fishing tackle and 1001 other hardware items in these neat plastic drawers and you'll always know where to find them! Clear plastic drawers for easier identification of the contents without having to open each one. Dimensions: 120mm (L) x 300mm (W) x 225 (H). (Components and accessories shown are not included). H 4587

**$8.99**

SAVE $4



Promotion from 30/8/06 to 26/9/06

DICK SMITH ELECTRONICS

# Kit clearance time

SILICON CHIP

**Fridge Alarm Kit**
Operates by detecting light entering the compartment area. Alarm sounds if the light is present for longer than the preset period. Supplied with all components, PCB, clear plastic case and front panel label. K 7216

LIMITED STOCK

$9.98

SAVE $10

**LED Roulette Wheel Kit**
Just like running your own mini Casino – simply press the button to set the ball rolling. It creates a clicking sound as each number is passed. Includes all components, PCB and necessary hardware such as mini speaker and switches and requires a 9V battery (not included). K 2804

LIMITED STOCK

$19.98

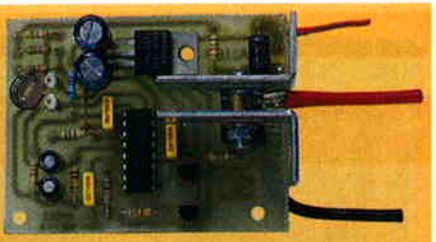
SAVE $16.52

**Mighty Midget Amplifier Kit**
This compact audio amplifier module can deliver up to 70W into a 4Ω load when powered from a 12V car battery. Supplied with PCB and all necessary components.
The perfect audio amplifier module for use in a PA, a tiny sub-woofer amplifier, a busking amplifier or car audio amplifier.
Kit supplied with PCB and all necessary components. K 5401

LIMITED STOCK

$29.98

SAVE $9.90



**DC Speed Control Kit**
Provides high current speed control for 12V/24V DC systems and is ideal for controlling 12V DC motors in cars (e.g fuel injection, water/air intercoolers and water injection systems). It can also be used for headlight dimming in the daytime, running 12V motors and pumps in 24V vehicles and is supplied with components and PCB. Maximum current: 15A (20A with optional diode) and is pulse-width modulated.
**Power source required:**
12V – 24V DC. K 3072

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**Vader Voice Kit**
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It's colourless, odourless and sneaks up on you.
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1. Warning level that flashes an LED.
2. Alarm level, the LED is fully switched on and the relay output triggered. Momentary or toggle relay operation.
Operates from 12V DC and kit is supplied with all specified components and hardware, printed circuit board (PCB), a pre-punched and screened metal panel, plastic case and a small satellite PCB which allows the constructor to mount the CO sensor remotely. K 4614

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**ESR Meter Mk 2 Kit**
Easily identify defective electrolytic capacitors. Allows in-circuit testing, features auto-ranging covering 0.01-99Ω, test lead resistance zeroing. This kit is supplied in full form complete with all components, hardware, PCB, case and pre-punched, silk-screened front panel. K 7214

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**Electrocardiograph Kit**
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**Remote Checker Kit**
Checks whether an infrared remote control is sending out a code when each button is pushed. K 3055

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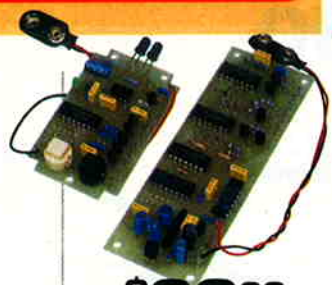

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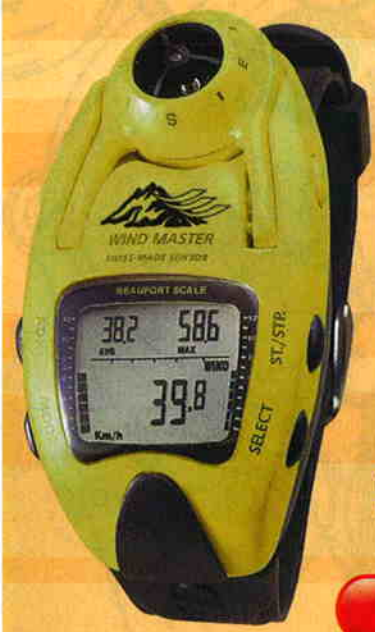


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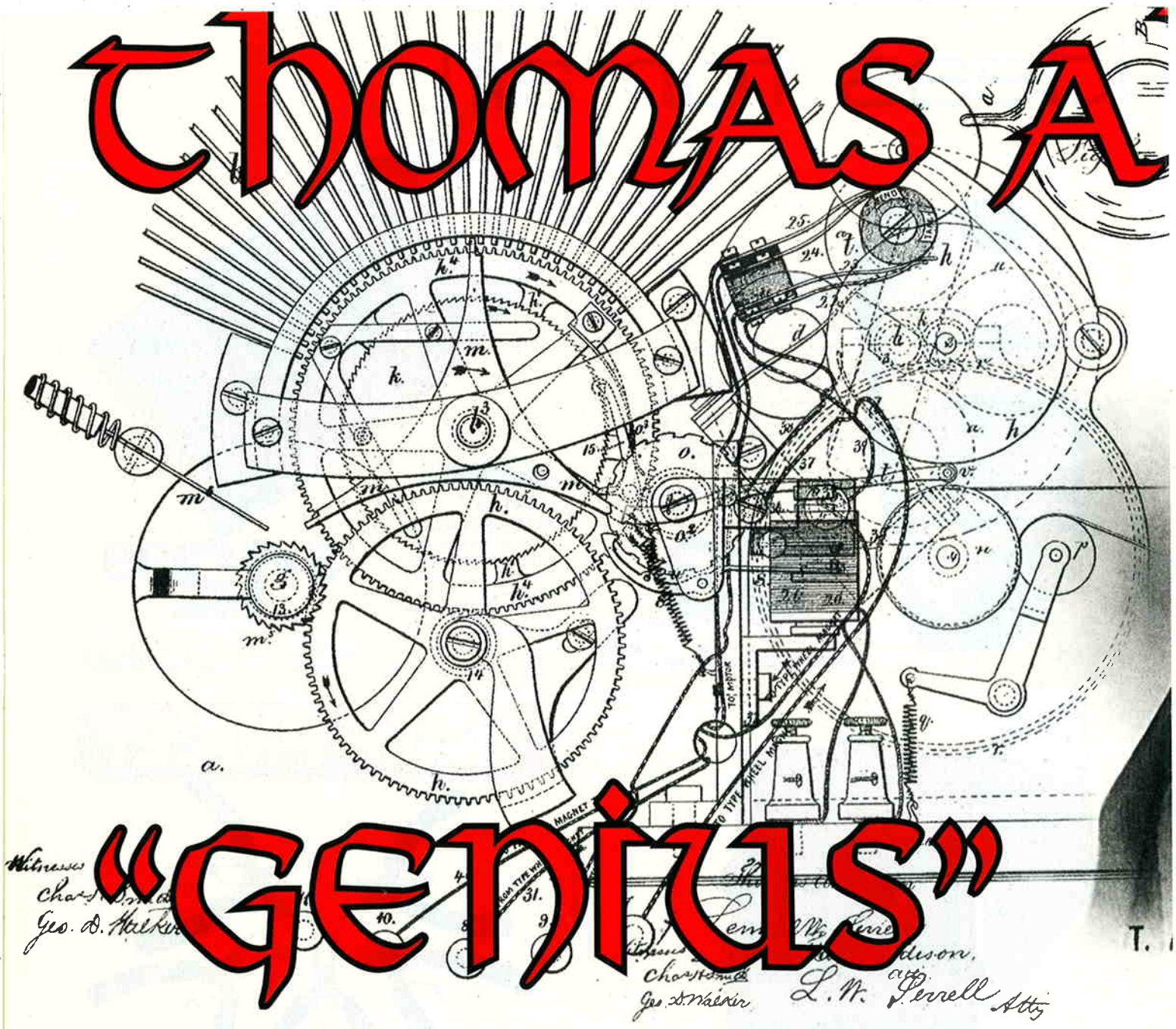
# Thomas A "Genius"



**Part 1 – By Kevin Poulter**

**Thomas Alva Edison** is given accolades as a genius and 'the man who made the future'. Certainly much of the technology we use today evolved from his research and products – technology like electric light and even the DVD disc.

Few have left such a footprint on the world as Edison, demonstrated by his inventions, products and millions of ephemera held in museums, libraries and private collections – engravings, photographs, notes, stories and books.

Edison's modus operandi was simple. So simple, anyone can be inspired to be as successful. All that's needed is passion, drive, study, endless experiments, comprehensive notes, a team of the best inventors and craftsmen, the best patent lawyers money can buy, almost no sleep (as you work around the clock), plus making and losing your fortune many times.

Edison's early years shaped his inventiveness and career more than most geniuses. Thomas was born in Milan (Ohio) to a middle-class family in 1847. In just a short time it was apparent he was extremely inquisitive, visiting shipyards for Great Lakes shipping and asking endless questions. If you are at a distance, why could you see a hammer hit a board, before you heard it? Why make the joints so tight? What is pitch made of?

Thomas was always getting into trouble. One day he fell while scrambling on a grain elevator and nearly suffocated as the wheat covered him. A few days later, investigating a bee's nest, an angry ram butted him. Another time, he chopped off the tip of his middle finger using an axe to shorten a belt.

Still not at school, Al (his nickname) was testing theories. He decided birds could fly because they ate worms.

Mashing worms into a drink, he

charged a poor girl with drinking it. She got sick but didn't fly.

When Al burnt a neighbour's barn down while experimenting with matches, the owner took him to the town square and publicly punished him over his knee. If all this sounds a bit dramatic, most Aussie country boys did much the same in their childhood (well, most didn't burn down the neighbour's barn)!

His public schooling at seven years old was just a short time, after his teacher told Al's mother he was 'addled', essentially meaning he was confused and not very bright.

After this news, his angry mother took him from class to home-schooling. Fortunately Mrs Edison had been a teacher and young Thomas was hungry to learn from every book he could find. He devoured facts and history and rarely forgot anything, possessing a remarkable memory.

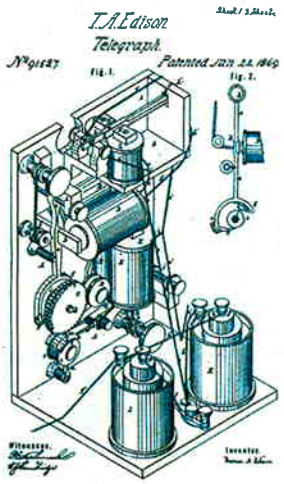
He read Sir Isaac Newton's two volume 'Mathematical Principles of Natural History' but didn't understand much of it. Years later he said "I can always hire mathematicians but they cannot hire me".

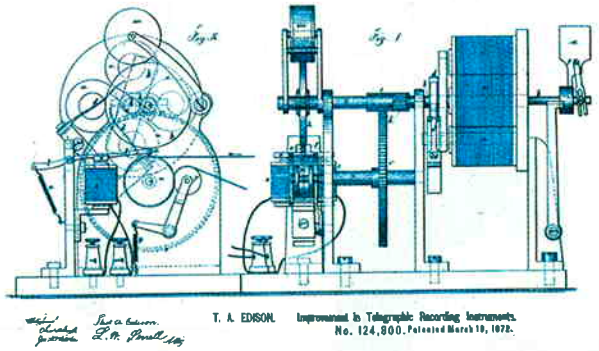
Al decided he now had the answer to flying but this time was again very careful in the experiment. Instead of trying it out himself, he got the chore boy to take triple the dose of Seidlitz Powders, figuring it would create copious gas and the hapless 'volunteer' would float like a balloon. Unfortunately, all that happened is the boy became very sick and Al was punished.

At age eleven, Thomas finally found a scientific book he could understand, 'A School Compendium of Natural and Experimental Philosophy'. Soon he set up a laboratory in the basement at home, eager to try the experiments.

On the back of his home-made table, Al had two hundred bottles, gathered from every home discard he could find. Each one was labelled 'Poison', with a skull and crossbones,

**On these and the following pages are just a few of the myriad of patents awarded to Edison, covering the period 1869 through 1881. So prolific was Edison and his team in applying for patents that the US Government Patent Office set up a special "Edison" office to handle them all!**




to keep family and friends from meddling. In reality, the bottles contained items like mercury, feathers, sulphur, beeswax and acids.

Al completed every experiment in the book during his eleventh year. Some years later, another boy who was to become his lifelong friend, learnt much from the same book. That boy was Henry Ford.

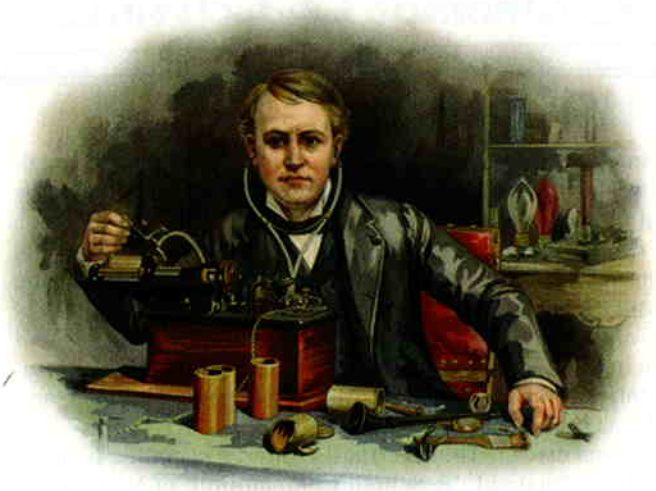
Thomas kept notes on all his experiments and pasted them in scrap-books. He continued this throughout his life, graduating to notebooks when in business. Three pages of rough sketches from one of his notebooks sold recently for US $1000.00

Considering Al made chlorine and oxygen gas in the basement and exploded a toy house with hydrogen gas, it's a wonder the family home wasn't destroyed. At this stage, there were two ways he made electricity, both from the book – by friction of rubber against glass and by moving a magnet. The latter was the forerunner of the giant dynamos Edison was to yet to invent to power towns.

Batteries were already in use in this era (1850s), especially to power the Telegraph, but they couldn't compete with steam or water for power. His experiments continued, so Edison became a very proficient chemist, but he wanted more than just some pocket-money from his parents.

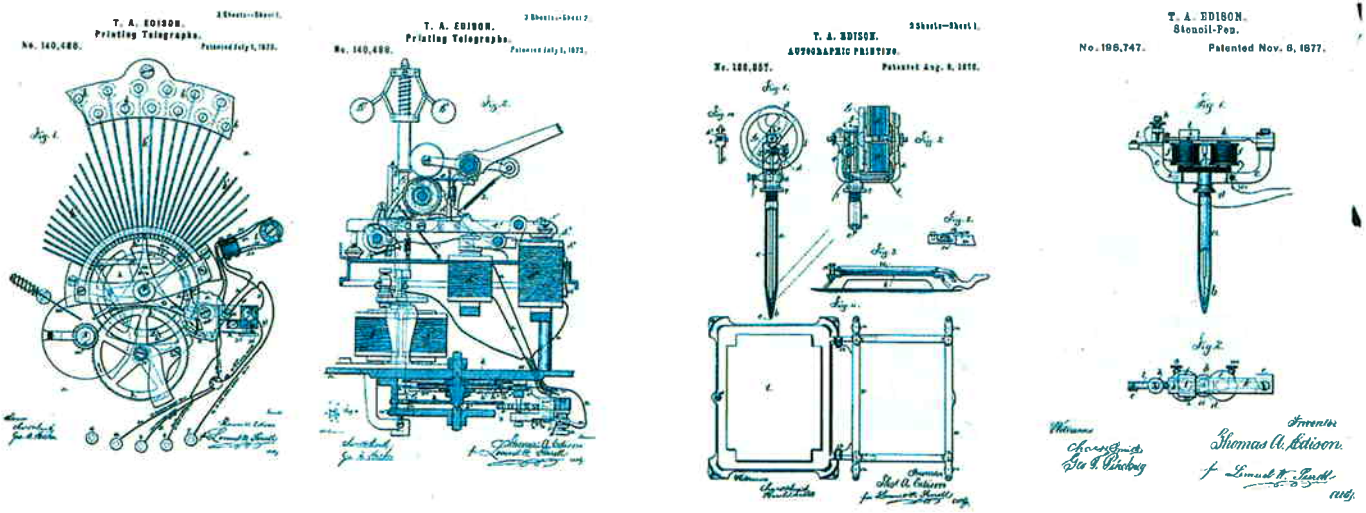
The railroad was built right up to his town and officials visited to promote rail's benefits to the town. Young Edison overheard two train officials saying they needed to hire a boy to sell newspapers and sweets on the train. After a family conference, at the age of 12 , Edison started in commerce on the railroad. He sold newspapers, novels, sandwiches and sweets.

On arrival at Detroit, Edison had an 8-hour stopover each time, so he explored. Soon he found the Detroit Free Library and looking at all the rows of books, decided if he read them



**Young Edison experimenting with his phonograph. His partial deafness encouraged him to produce equipment that was loud and clear. His 'headphones' resemble a stethoscope. Colour images of Edison are rare, as the process of colour photography and printing was not common in Edison's time.**

**April 18, 1878 was a memorable day for Edison. He was photographed at Mathew Brady's world-famous Washington studio, then demonstrated his phonograph to the Academy of Sciences and later to President Rutherford B Hayes (ending up after 3AM!). Not bad for a lad that never completed any more than a few years schooling!**



all, soon he would know almost everything in the world.

As the library kept buying books, it became too much to read them all, so Thomas began to concentrate on scientific texts. When tired or bored he went to the locomotive works and watched the boilers being made and tested.

At 13, he also sold his wares in the towns where the train stopped. The profits went toward more chemicals. And profits were good, up to $40 a month. With so many enterprises, Thomas hired three helpers, to run his magazine and newspaper outlet in Port Huron, plus a greengrocer store selling fruit and vegetables he shipped from Detroit and from farmers along the rail route.

Each station his train visited had a telegraph. Thomas wanted to know how electricity was used to send Morse in an instant between towns. So he made a crude set-up in his basement, connected by stovepipe wire to his friend, half a mile away. Bottles were nailed to trees as cable insulators and at one point, a cable salvaged from the river became a conduit to carry the wire under a road.

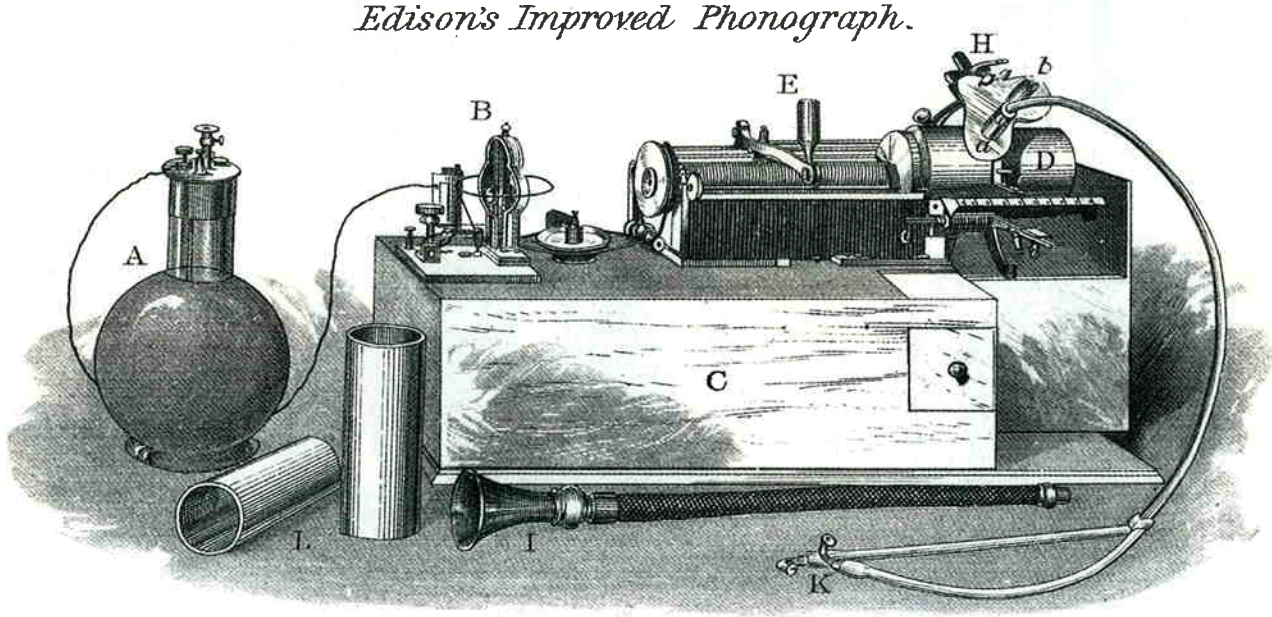
Batteries were very expensive, so Thomas looked at alternatives. He grabbed a tomcat, connecting the fore and hind feet into the circuit as electrodes. By furiously stroking its fur the wrong way, a huge electrical arc was produced but the cat was not impressed and escaped. With the experiment unsuccessful, there was no alternative but to save for batteries.

On making the system operational, Thomas and his friend learnt Morse-code and got in at least half an hours practice each evening. After a while, he convinced his parents he could practice longer and only get six hours sleep, then do an 18-hour day. This was the beginning of his career pattern of long hours and little or no sleep.

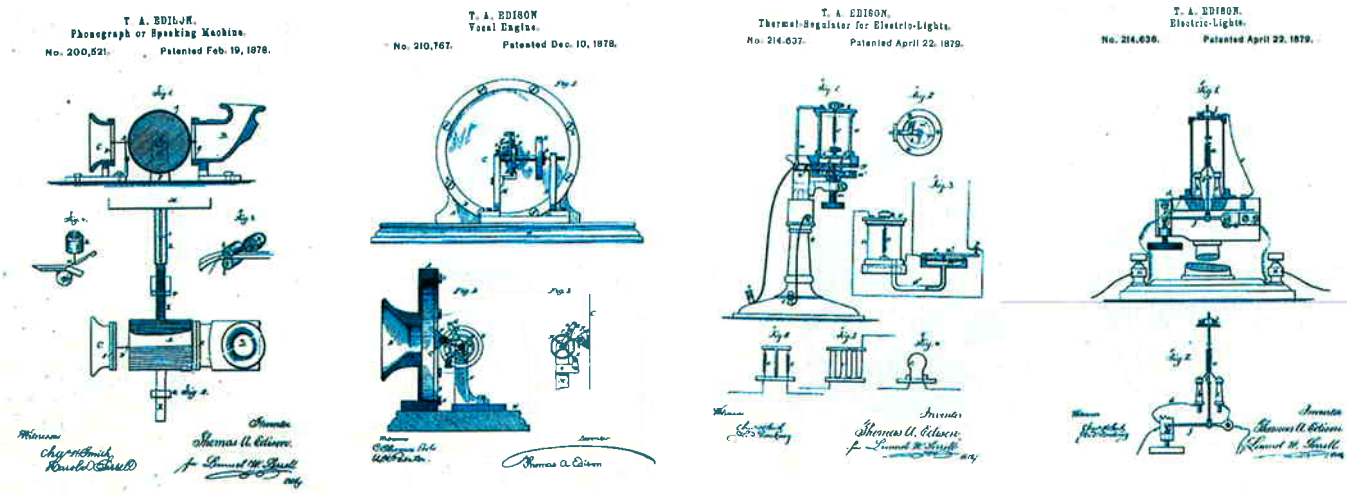
One third of the baggage car was allocated to the train boy for his supplies and base, however Thomas was now able to afford chemicals and materials for experiments but had little time. So he turned 'his' area in the car into a mobile laboratory.

As a brilliant 14-year-old, his reference book at this time was Fresenius' 'Qualitative Chemical Analysis', a book still

*Edison's Improved Phonograph.*




**After inventing the phonograph in 1878, Edison was distracted by other projects and made few improvements. When Bell made an electric gramophone with wax cylinders, Bell offered to manufacture it under both names. Edison was shocked plus annoyed and flatly refused, privately calling his competitors 'a bunch of pirates'. Soon he released his own electric phonograph, with solid wax cylinders, so they could be shaved and used more than once.**




used by colleges and universities in the 1930s.

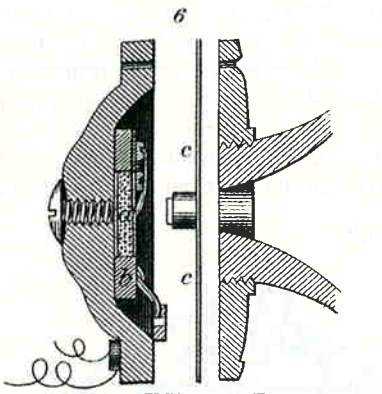
At every opportunity, Thomas rode up front with the fireman and engineer. One evening, the crew were too tired after attending the trainmen's ball, so Thomas took charge. The train limped to its destination, as Thomas overfilled the boilers with water.

Differences between the North and South states were not only political but cultural, with the North being industrial and the South growers with black slaves. When Lincoln won the election, the southern states started seceding from the Union.

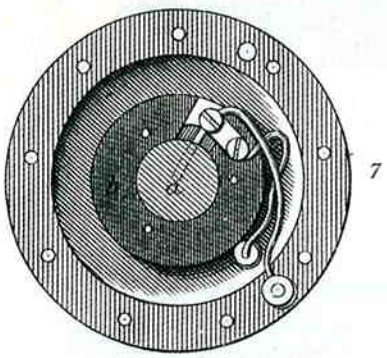
Little over a month later, the war between the states began and Thomas no longer had to hawk his newspapers – they sold as people boarded the train.

Thomas figured he would make more profit if he printed his own newspaper. After all, there was plenty of gossip in the city and he picked up the latest news from telegraph operators, so he could publish much later breaking news than the traditional press.

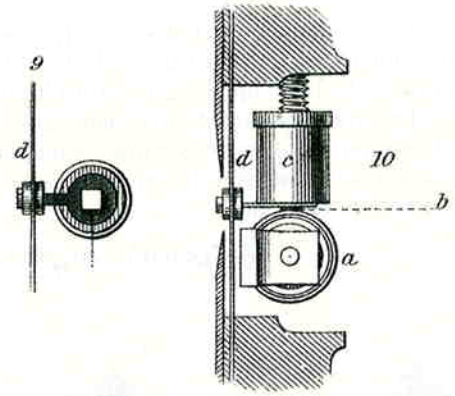
He purchased a hand-press, previously used to print menus at a hotel, plus a bag of metal type and enlisted the services of another boy as a 'news hound'.

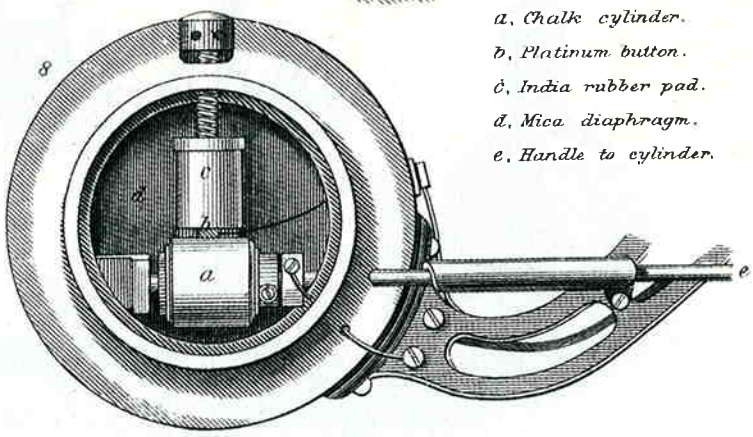



*Section of Edison's Transmitter.*




*Edison's Transmitter.*
*a, Carbon. b, Vulcanite ring. c diaphragm.*




*a, Chalk cylinder.*
*b, Platinum button.*
*c, India rubber pad.*
*d, Mica diaphragm.*
*e, Handle to cylinder.*

*Receiver of Edison's Loud speaking Telephone.*

**Edison made an improvement to the telephone in 1876 – the Carbon microphone. This microphone had such good performance, it was used extensively for about 80 years. The receiver (earpiece) shown above relied on clockwork and three chemicals, which had to be moist!**



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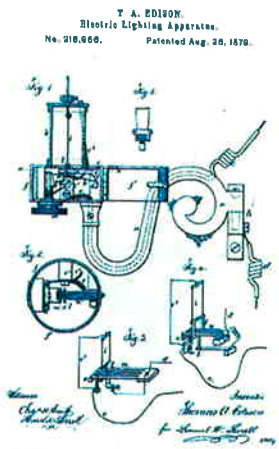
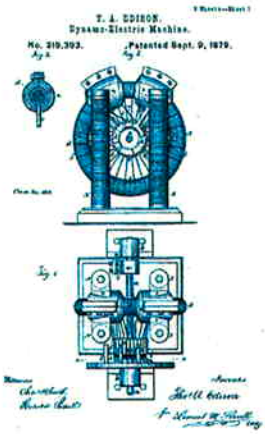
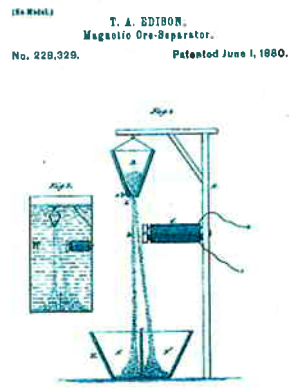
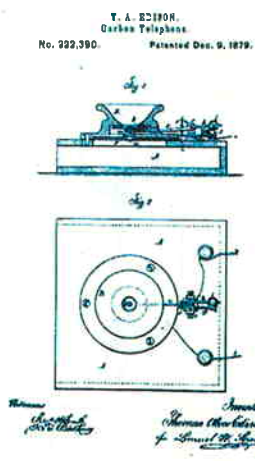



The travellers and public were impressed and within a month, his single-sided 'Weekly Herald' had four hundred subscribers, at eight cents a month. With his newspaper, vegetable store and train concession, Thomas was clearing $60-$80 a month, a huge sum for a young lad.

George Stephenson, the famous British engineer, inspected the railway and was so impressed with the Weekly Herald, he sent a copy to the London Times, declaring it was the first newspaper in the world to be published on a moving train.

In 1862, the battle of Shiloh was rumoured to have claimed 60,000 lives and was continuing. Edison saw the crowds milling around bulletin boards, so he asked the Detroit operator to telegraph the towns on the route and place bulletins on their wall that newspapers were coming. In return, he offered the operators subscriptions to journals and a daily evening paper for six months.

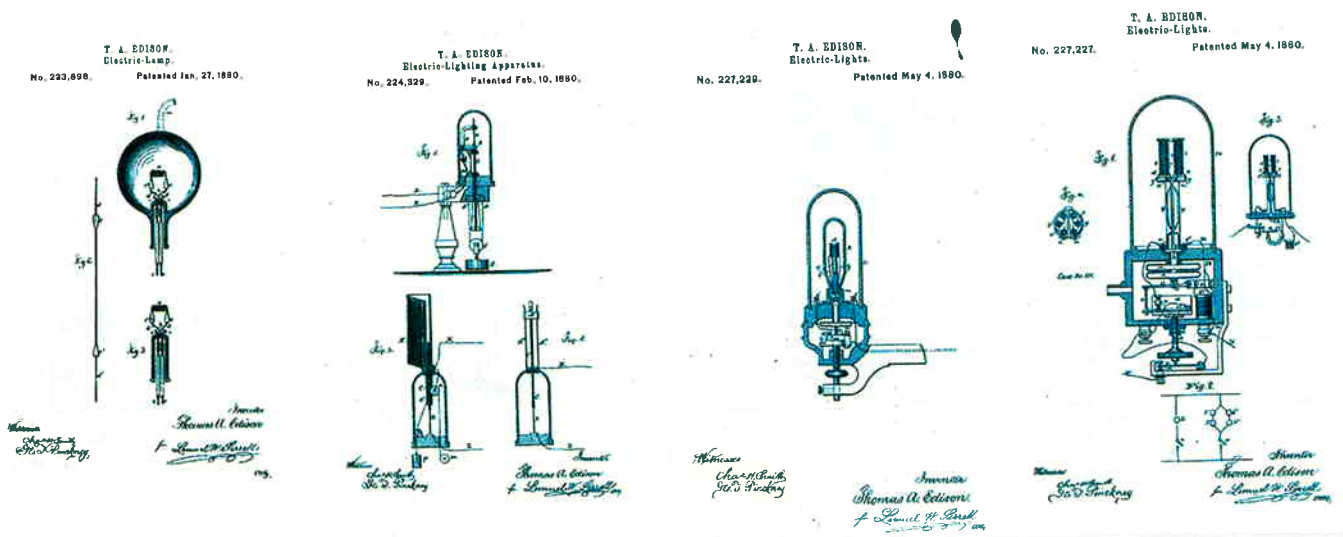
Thomas decided to purchase one thousand copies of the Detroit Free Press, (instead of his usual two hundred) but could only pay for three hundred. The superintendent of despatch refused to give Thomas credit, so he went upstairs to the Editor, now asking for one thousand five hundred papers. This was beyond the Editor's charge, so he took Thomas to the owner's office. After some deliberation, he was given the papers and loaded them onto the train with three other boys.

At the first town, he normally had a couple of customers, but was mobbed by a crowd, selling about one hundred and fifty newspapers at five cents each. Raising the price to 10 cents each, he sold so many on the way, by the destination at Port Huron, he only had a few copies left, now at 25 cents each. This clever enterprise made Edison over one hundred dollars in one day.

Five months later, in 1862, the temperature was over the century (F) in the shade, as Thomas waited beside the line at Mt Clemens station. He was shocked to see the son of the station agent collecting pebbles on the track, with a train approaching. Thomas leapt to save the child, a very close shave – so close, part of his shoe was torn off.

The agent was immensely grateful, offering to teach 15-year-old Edison how to become a railway telegraphist. Nothing could be better for Edison, as he was interested in the technology, noticed the operators were well-paid and they had considerable spare time.

Thomas engaged his friend to do the paper run on the rest of the line, so he had eight hours a day to study telegraphy at Mt Clemens. During his 18-hour days, Thomas still printed




his newspaper and carried out experiments in his mobile laboratory.

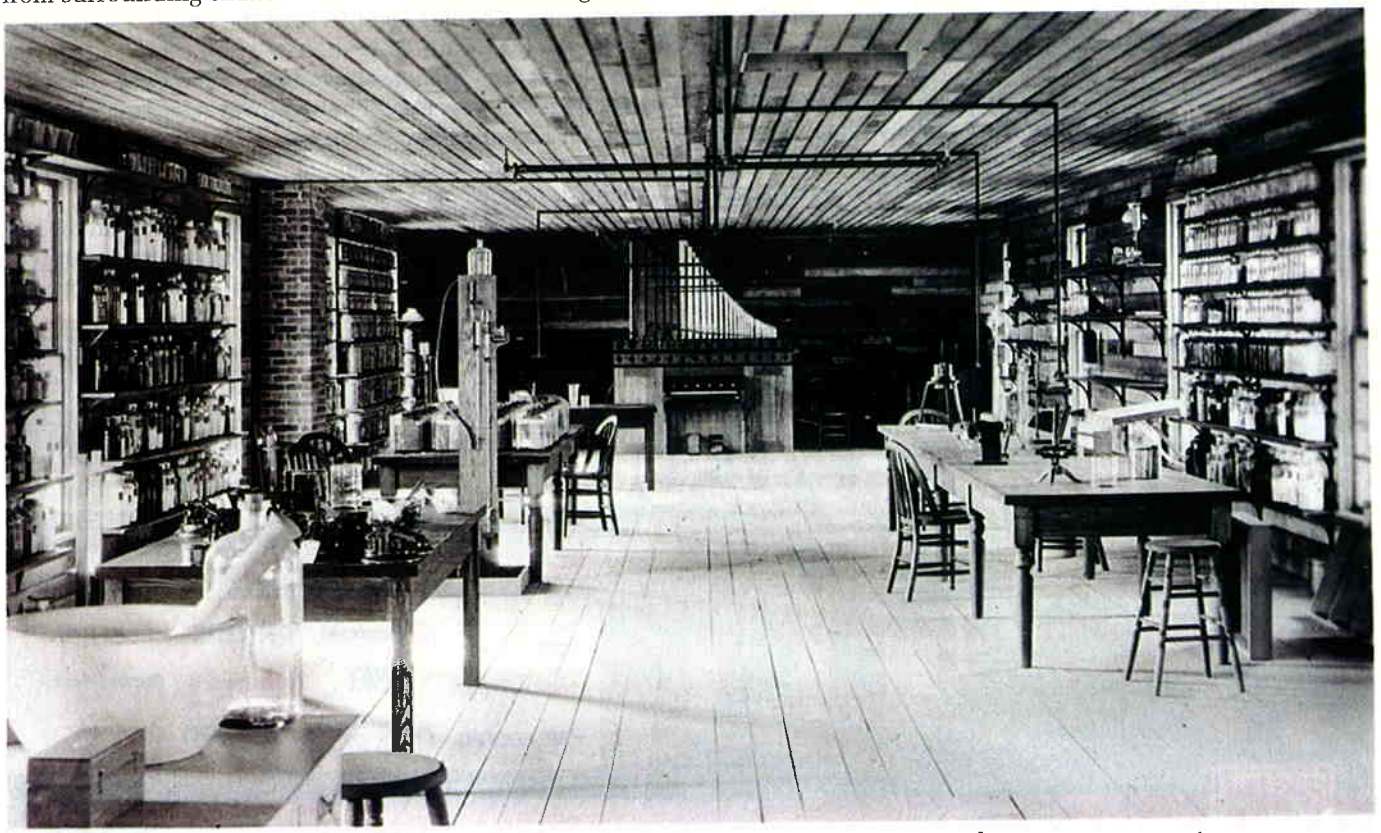
Luck was about to take a turn for the worse. Selling papers at Fraser station, he missed the "all aboard" call and hurtled after the moving train. At last he grabbed the handrail, but out of breath and with hands so cold, he couldn't haul himself on board. A brake-man grabbed him by the scruff but when that didn't work, reached for his ears. As his ears were pulled, Edison felt something snap. From then on, he began to go deaf.

After initial dismay, Edison used his impairment to advantage, finding he could operate a telegraph with less distraction from surrounding chatter and noise. It also encouraged him to make the phonograph and telephone loud and clear, so he could hear them.

His career as a train boy came to an end when the mobile laboratory jolted over a rough rail section, spilling a stick of phosphorus and setting fire to the baggage car. The conductor put out the fire and ejected Edison, his lab and press from the train at the next station.

In time, Edison decided the 'Weekly Herald' was not profitable, so he opened a new local newspaper, 'Paul Pry'. It contained gossip about the town and even exposed shady business dealings. Soon after being tossed in the river by an angry reader, Edison ceased publication.

The lure of the telegraph beckoned and Edison installed a



**Part of Edison's lab in Menlo Park. Note the pipe organ at the rear, the vertical post with apparatus to create a vacuum and the bank of batteries behind it (both on the left). Edison's early labs were moved and recreated at the Ford Museum in USA and can still be seen today.**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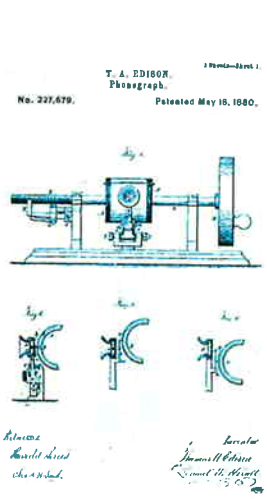
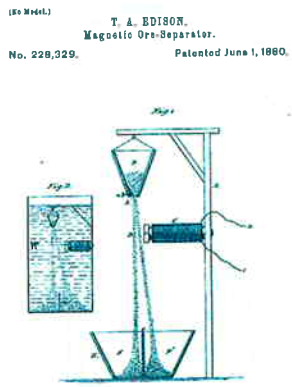
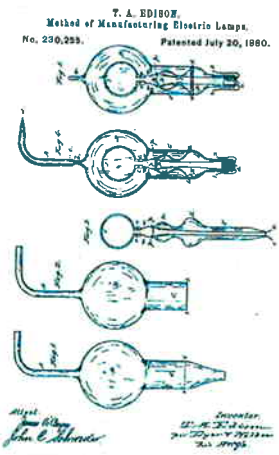
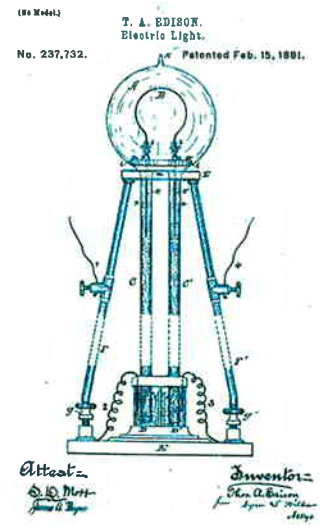



telegraph between Port Huron station and the Chemist, a mile away. Stovepipe wire was nailed along the top of a rail fence. Messages were clear on fine days but poor in the rain. As few messages were sent, he served in the Chemist store.

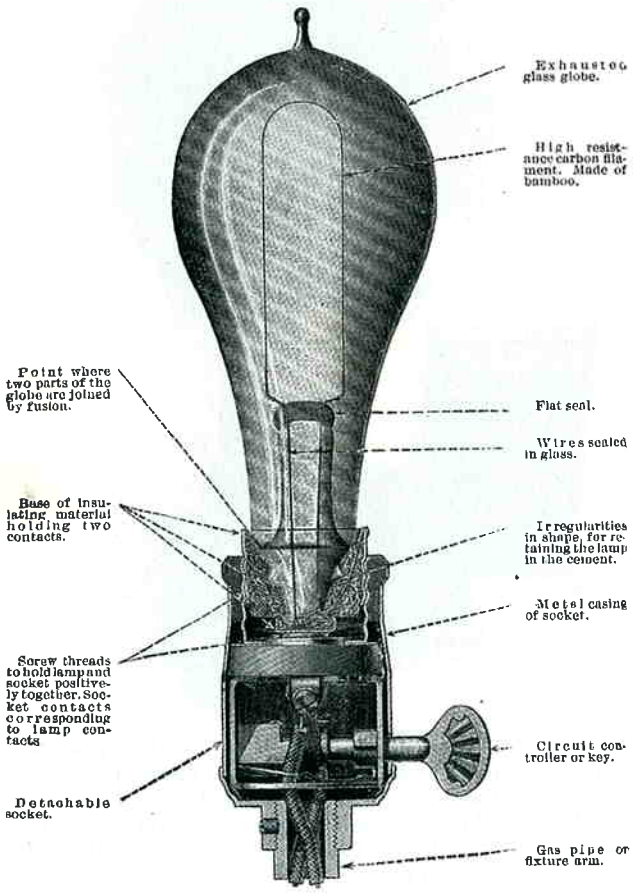
When the station telegraph operator left to join the military telegraph corps, 16-year-old Edison applied for the position and got it. The telegraph office was inside the jeweller's store, which also stocked books, guns, organs, dominoes and china.

Ever the convincing salesman, it didn't take long for Edison to move his lab into the store. In time there seemed no future in this position, so he applied for and got a telegraph operator's job up the line, in Ontario, Canada. The shift was 7 to 7 in the evening, but Edison researched and worked on his own ideas during much of the day as well.

Most night telegraphists fell asleep during their night shifts, so the railroad company devised a system where operators had to telegraph their number to the other end every hour, to show they were awake. Edison's was number 6.

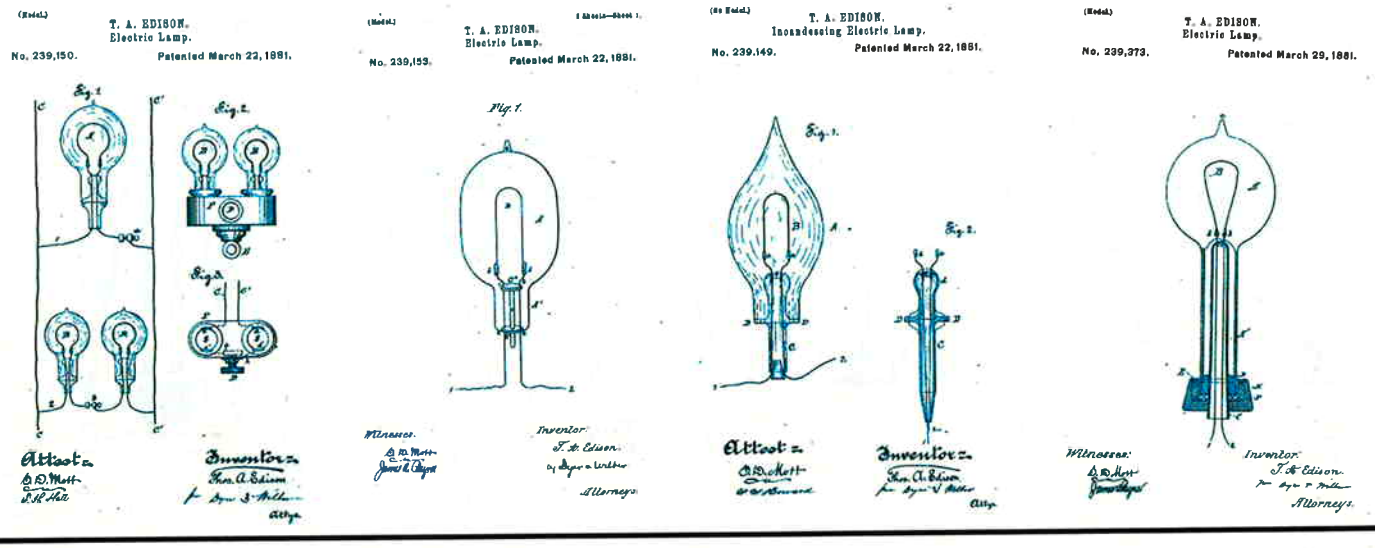
To catch some sleep, Edison had the night watchman wake him every hour, then came up with a better plan – a device connected to the station clock. Every hour a notched wheel would close the electrical circuit, sending number 6.

This became undone when the assistant chief telegraphist


Exhausted glass globe.
High resistance carbon filament. Made of bamboo.
Point where two parts of the globe are joined by fusion.
Flat seal.
Wires sealed in glass.
Base of insulating material holding two contacts.
Irregularities in shape, for retaining the lamp in the cement.
Metal casing of socket.
Screw threads to hold lamp and socket positively together. Socket contacts corresponding to lamp contacts
Circuit controller or key.
Detachable socket.
Gas pipe or fixture arm.

The Edison Lamp.

**(Left): Edison tried many filaments in his lamps, to gain longest life and brightness.This pre-1890s type used a high resistance carbon filament, created from a process of carbonising bamboo. Edison searched the world for materials like this bamboo.**
**(Above) The Edison electric lamp evolved with constant improvements. This example still had the evacuation nipple on top, however the brass Edison screw fitting has reached its final shape by this time.**




stopped off at the station one night, finding Edison asleep and witnessing the contraption in action on the hour.

Edison's idea of a notched wheel setting off a switch is nearly identical to the mechanical automatic school bell system, still in use in Australian schools a hundred years later in the 1970s. In fact, timer power outlets with this concept are still sold in stores today.

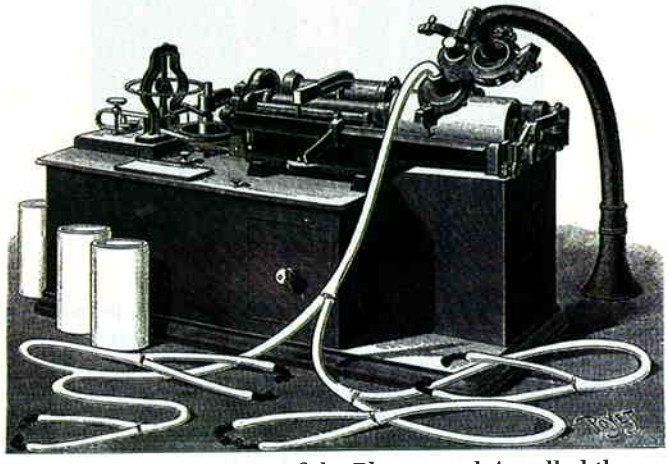
He was forced to discard the device but remembered the principles of operation that would one day make him a fortune.

A number of telegraph jobs ensued and Edison studied how repeaters functioned, setting up two where he worked. He also considered "if Morse can be stored on paper tape, sound should be recordable too". All these experiences would shape Edison's career.

Al Edison still spent his money on chemicals and books. In Louisville, he went to an auction and won 20 copies of the North American Review, for $2. At three the next morning, he was travelling to his lodgings with the bundle, when a bullet whizzed past his head. Turning around, a policeman asked why he didn't stop when commanded, as he looked like a thief with possessions from someone's home. 19-year-old Edison explained he was deaf and the policeman apologised.

Edison continued to have a series of telegraphic jobs, sometimes causing his own downfall, like when he spilt sulphuric acid in another makeshift lab, ruining the desk and carpet in the manager's office below. He was invited to leave.

One of the biggest difficulties with telegraphy was that the lines would get clogged in busy times, with queues of unsolved messages. Edison worked on this for years and at age 26, he sold the Quadruplex – a system for sending four messages at once – for thirty thousand dollars.



**The most important part of the Phonograph is called the spectacle frame. (top right) On one side is the recorder, on the other, the reproducer.**

**This stunning Idelia, an extremely rare and exceptional phonograph made by Edison, features a mottled metal finish. It is a 2 and 4-minute phonograph with model O reproducer and an 11-panel Cygnet horn with original wood grain paint. All parts have the special metal finish. It recently sold for $54,000!**
*Photo by Guido Severijns, Netherlands*



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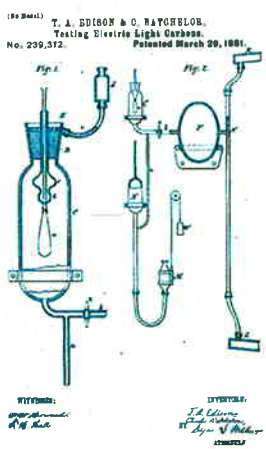


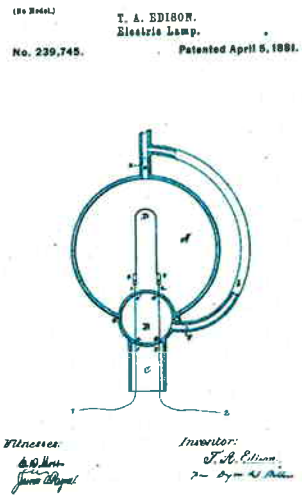


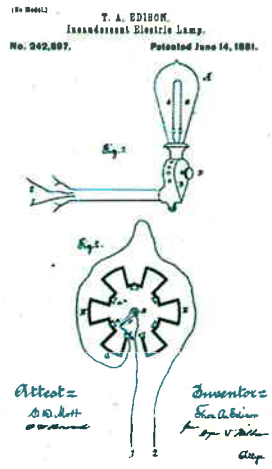


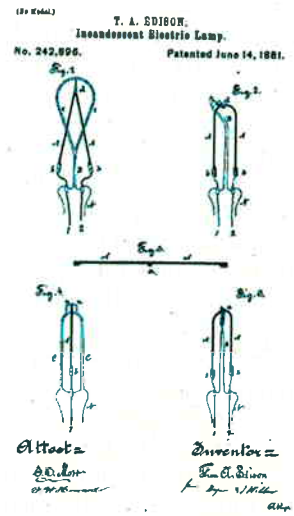


To give an idea of the lifestyle of the man at the time, picture a scientific mind and a scruffy dresser whose home was a single room with a folding cot, lab, books, oil stove and surplus telegraphic equipment – a room full of ambition. His hobby was doing chemical experiments. With his obsessed scientific mind, poor dress and anti-social due to shyness and poor hearing, he was not yet married.

His first employer, the Grand Trunk Railroad, was in trouble. One of the two cables across the St. Clair river had broken. Edison set up a device to make one cable do the work and the grateful railway company gave him an unlimited pass. Apparently they had forgotten this was the same lad who was literally tossed out of their employ four years earlier!

The rail pass was great for getting to his next opportunity, Western Union in Boston. Edison was soon known as one of the best operators in Boston. By reading Faraday's electrical books and trying his experiments, it was like Faraday himself was teaching Edison. One experiment was adapted to combat the swarms of cockroaches. At night, the cockroaches would come into his office, looking for food. Edison invented a cockroach 'exterminator'. As they walked to planted food between two strips of tinfoil, the battery was turned on.

Scientists believed producing papers, magazine articles and books was prestigious, plus a way to attract funding and sales. Patents were also essential to protect ideas, so much was published by leading scientists, or authors who approached them. This was used to advantage by others eager to learn, copy and improve on electrical inventions.

This pattern was employed with great success and at great expense, through Edison's working career.

Boston was a centre of electronics inventions and production, so Edison visited and lurked around many of these stores, making notes on the equipment. He was becoming noticed, through his product, the double transmitter, which enabled two messages to be sent in opposite directions on the one wire, by regulating the strength of the current.

His invention was written up in Telegrapher, the magazine of the National Telegraphic Union, in April 1868. Next month his combination repeater was in the magazine and the month after, the double transmitter was mentioned again. But Edison wanted income more than fame.

His first really great invention was a vote counter for Congress. Counting of votes was very time-consuming, so Edison's invention would save these important people many hours a week. Problem was, they looked at his beautifully constructed invention and declared they actually liked the time out for minorities to stall bills, plus networking, relaxing and other distractions. So his great project was brushed aside, with hardly a consideration.

Throwing himself back into inventing, Thomas made

THE EDISON
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COMPLETE
PRICE $20.
Produces the same results as the other famous models of the GENUINE EDISON PHONOGRAPH. Makes records; reproduces records. Equipped with shaving device. Simplest, most durable, and cheapest talking-machine
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ALL GENUINE PHONOGRAPHS bear this signature:
TRADE
Thomas A Edison
MARK
NATIONAL PHONOGRAPH CO.,
St. James Building, Broadway & 26th St., New York.
Edison records 50 cents each, $5.00 per dozen.

**Edison originally manufactured and sold his Phonograph through the National Phonograph Co. When they went bankrupt, he acquired the company and the Edison brand commenced.**

an improved Stock Ticker that only worked on two wires, instead of the usual three. A stock ticker is like a telegraph that reports the share-market figures to brokers and buyers, anyone who can have a ticker installed. Sales went well in Boston but his sales representative kept all profits himself, while Edison was trying to sell the unit in New York, where they were not interested.

About the same time, 21-year-old Edison set up a private telegraph system between businesses in Boston. The key to his equipment was Morse Code printed onto paper tape, a system very similar to telex machines still in use 100 years later.

Despite many set-backs, Edison decided to be a full-time inventor, arriving in New York in raggy clothes with ten cents in his pocket, in 1869. This was an inspired young man, living on a dream.

He slept on the floor of the Gold Indicator Company. Three days after arriving, the chatter of the transmitter went silent. The mechanics didn't know what to do and three hundred messenger boys from brokerage offices were sent to ask for the rapid restoration of the service. Edison calmly found and fixed the problem. Within two hours the entire network was 'on air'.

The next day Edison was made superintendent of the plant, at a salary of three hundred dollars a month.

Buoyed with this success, he joined two mates to open a new company, the Pope Edison company. This electrical engineering and telegraphic agency, ran on essentially three young men's dreams and ambition. They offered telegraphic instruments, construction and maintenance contracts, devices like fire-alarms, obtaining telegraphic patents, designing and constructing experimental apparatus, wood engravings and a purchasing agency.

After his job and daily conference with his partner, Edison slept for 3-4 hours.

Soon his previous employer bought out the fledgling business and put him to work on the stock ticker. After making good progress with variants, like a simple and less fault-prone version, his boss asked him for the price to buy all his existing patents. Edison thought $5000 would be fair, but was offered $40,000!

With no experience in banking and accounts, he asked for the amount, which was paid by the bank in low denomination bills. Young Edison stuffed his clothes full of the king's ransom and nervously kept the money overnight, until he was shown how to bank it.

The money enabled the 23-year-old to open a store making stock-tickers, then a larger store, employing 18 men, in around-the-clock shifts. Edison worked 20 hours a day, supervising both shifts.

In an acid-stained suit, dirty and dishevelled, he was often mistaken for one of the workers. Edison evoked employee loyalty, due to his diligence and respect they had for him, many staff later becoming leaders in utilities and electronics.

It wasn't long before Edison employed over 300 people. Women operated his automatic telegraph, which made perforations in paper, using a keyboard.

In 1873 he watched 16 year old Mary Stillwell typing and asked her to marry him. They got married and on his wedding day, Edison worked until after midnight, until a friend helped him home.

He must have spent some time at home, as two children arrived, nicknamed 'dot' and 'dash'.

Edison moved his business to a more tranquil location, Menlo Park, where he established factories, later known as the 'invention factory' and Edison himself was known as 'the

**The phonograph bought entertainment and music to isolated families, especially farmers, across the globe. Three types were available: hand crank, then clockwork motor and battery electric. The wind-up type was popular, as it was maintenance free and cheaper than battery power.**



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**The Edison Standard Phonograph became available in 1898, the first phonograph to carry the Edison trademark design. Standard-sized cylinders were typically 11cm long and 55mm in diameter, played at 120 RPM and priced at 50 cents each. An early disadvantage was the cylinders were only two minutes long. There was no mass-production method, so performers had to record repeatedly, to make a saleable quantity.**

Wizard of Menlo Park'. Inventions didn't just need inventors. Craftsmen produced beautiful metal, glass and wood engineering in workshops equipped with metal and wood lathes, drills, planers and milling machines, all driven by one of the finest steam engines in the country.

Menlo Park was described in the book 'Edison And His Inventions', in 1898: *'Far superior to any laboratory in the world. It is not an uncommon thing for Mr Edison to make an invention in the morning and before night receive a working model. In this stupendous and splendid laboratory, the great professional inventor is now at work, day and night, astonishing the civilised world by the character and number of discoveries.'*

He took out about one patent every two weeks – so frequent the patent office even had a special department for Edison patents – eventually achieving nearly 1500 patents, from USA to Tasmania!

Edison developed clean, efficient power for towns and countries, building dynamos with ninety percent efficiency and making the electric lamp commercially viable. Motion pictures, telephones, cement, electric railways and the gramophone owe much to Edison – a man for his time.

He built empires of businesses around the world, worth ten to fifteen billion dollars by the 1930s – all from a boy who had a short time at school and described as 'addled'.

## Next month in Part 2:

### From rags to billions – winning the patent wars.

References and further reading: www.aaa1.biz/sc.html

microbric™ VIPER
The Microbric Viper is a perfect entry point into robotics and programming, or the ideal compliment to your existing robotics line up!
All modules are fully assembled, meaning there is no need for a hot soldering iron to build your robot. This makes the Microbric Viper perfect in an educational environment.
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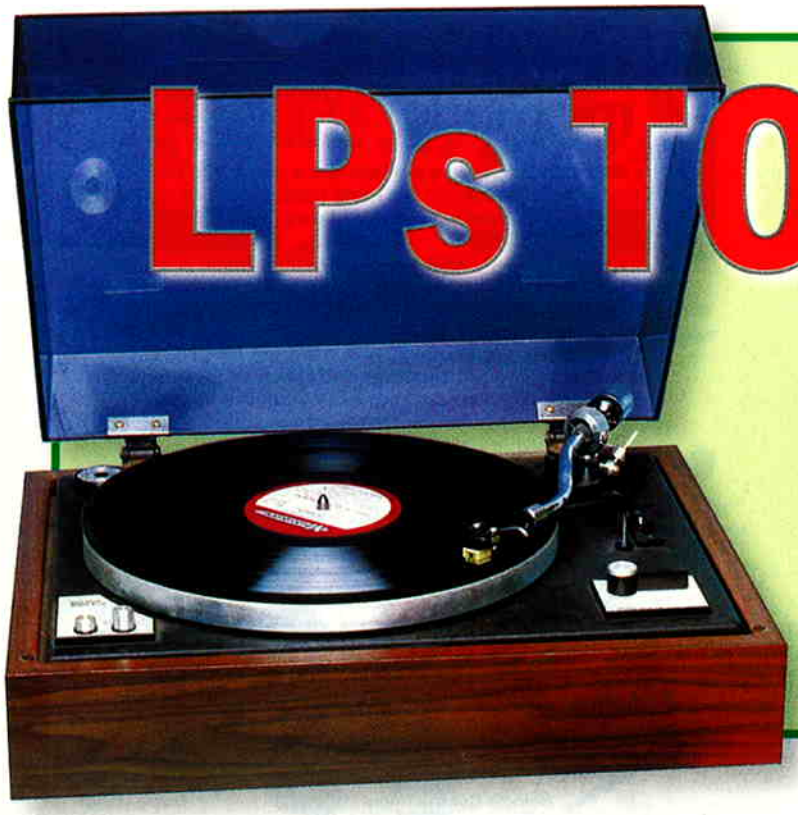
# LPs TO CDs



**Want to transfer your old LPs or 78 records to CD or MP3 format? Here's how to go about it and get rid of surface noise in the process.**

By JOHN CLARKE

COMPUTER TECHNOLOGY now makes it easy to restore your old vinyl records and convert them to CDs or MP3 files. You don't require an expensive sound studio to do it, just your PC and suitable software.

In fact, many owners of personal computers don't realise that they already have powerful audio editing tools just waiting to be tried. Correctly used, these tools will let you listen to your favourite recordings once again without the usual background clicks and pops and surface noise.

Of course, to play back your old LPs (or 78s), you'll need a suitable turntable. You'll also need a stereo amplifier with RIAA preamplifier stages, to process the output from the turntable's magnetic pick-up cartridge such as the one described in the August 2006 issue.

## Making it better

Often, you don't have to buy add-on packages in order to process the audio from your LPs. Instead, the software is usually bundled with your PC's CD or DVD burner. These software packages commonly include such enhancements as de-clicking and noise reduction.

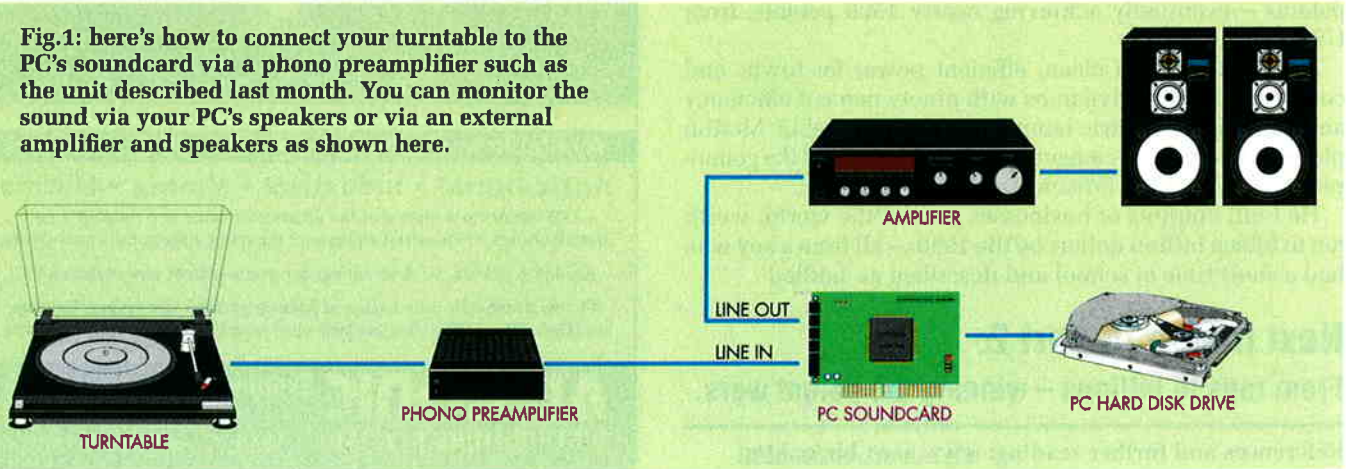
In fact, the quality of the sound after processing a recording using such software can be quite a revelation. The unwanted noise is effectively filtered out, leaving you with crystal-clear sound.

To appreciate just how well you can clean up a recording, take a look at the audio signal screen grabs shown in Figs.2 & 3. First, a small section from an audio track on an LP record was recorded using the Nero Wave Editor. Fig.2 shows this audio track section after it has passed unprocessed through our Magnetic Cartridge Preamplifier (both left and right channels shown).

Notice the small sharp spikes in the waveforms of Fig.2. These are the clicks and pops that you normally hear when playing a record.

Now take a look at the second screen grab (Fig.3). In this case, the signal

**Fig.1: here's how to connect your turntable to the PC's soundcard via a phono preamplifier such as the unit described last month. You can monitor the sound via your PC's speakers or via an external amplifier and speakers as shown here.**



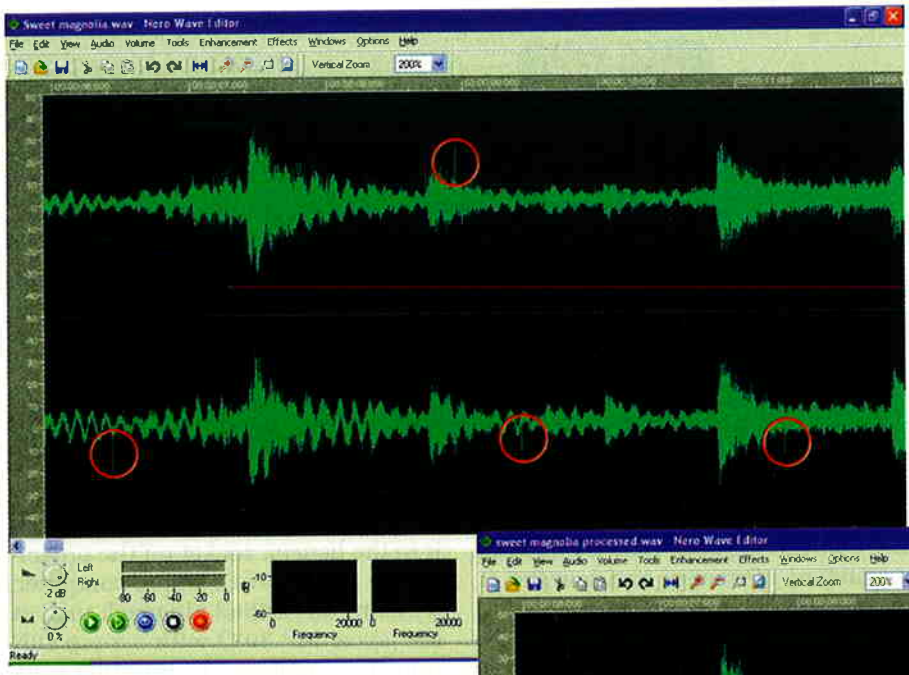
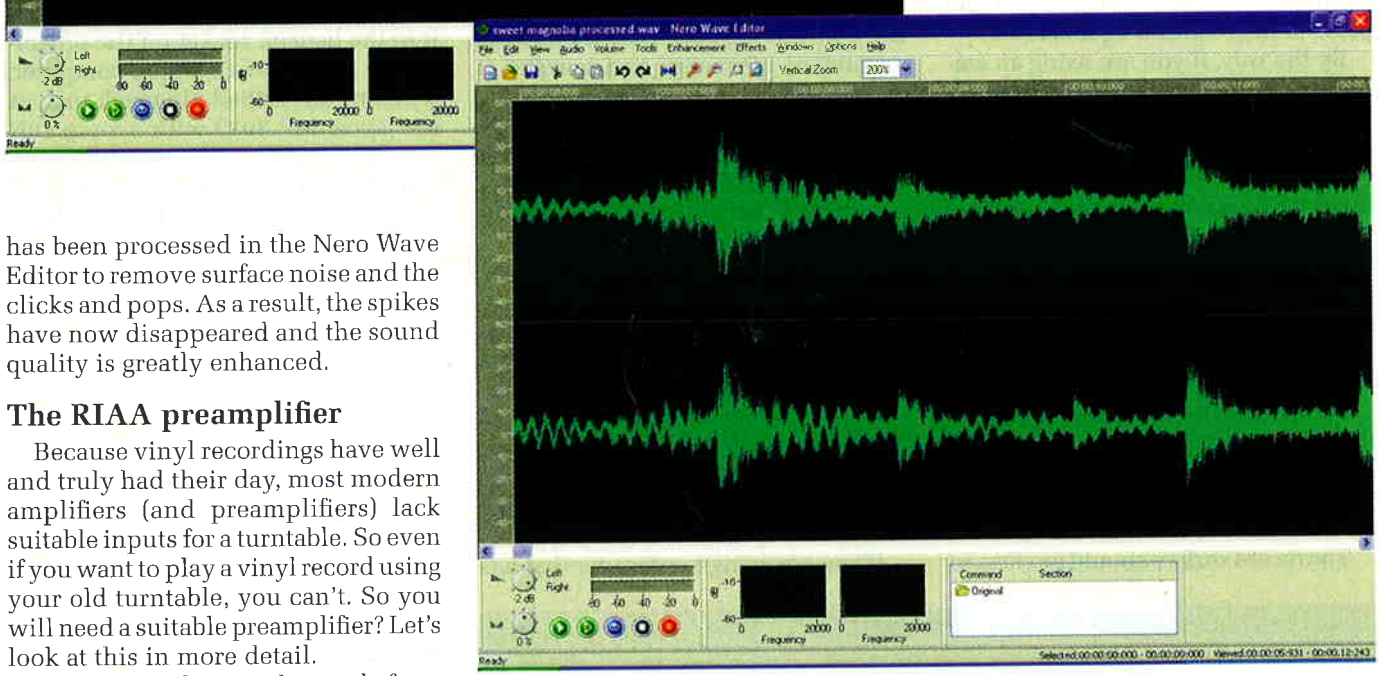


Fig.2 (left): this screen grab shows a small section of a recorded audio track from an LP record prior to processing. The small sharp spikes (circled) are the clicks and pops which are picked up due to imperfections in the record's surface.

Fig.3 (below): this is the signal after processing in the Nero Wave Editor to remove surface noise and clicks and pops. The spikes are now gone.



has been processed in the Nero Wave Editor to remove surface noise and the clicks and pops. As a result, the spikes have now disappeared and the sound quality is greatly enhanced.

## The RIAA preamplifier

Because vinyl recordings have well and truly had their day, most modern amplifiers (and preamplifiers) lack suitable inputs for a turntable. So even if you want to play a vinyl record using your old turntable, you can't. So you will need a suitable preamplifier? Let's look at this in more detail.

In order to play vinyl records from 1953 onwards, your sound system must have an RIAA preamplifier. This gives a standard equalisation specified by the Recording Industries Association of America – see Fig.5.

RIAA equalisation compensates for the way the audio signals are recorded via the spiral groove on the vinyl surface – ie, with the treble boosted and the bass curtailed. During playback, the reverse happens, with the bass frequencies suitably boosted and the treble cut.

During the recording process, the bass frequencies need to be reduced in level to prevent over-modulating the groove and breaking into the adjacent track. In addition, the fact that a magnetic cartridge is used for playback means that the levels will automatically be greater for the higher frequencies compared to the lower frequencies. Hence, RIAA equalisation was adopted as the standard many years ago.

## 78 RPM records

Unfortunately, the RIAA standard is unsuitable for playing 78 RPM records and pre-1955 LPs. These older records were recorded without adopting any particular response standard and most record companies had their own method of tailoring the response.

To make matters worse, a rotational speed of 78 RPM is not necessarily the correct value for all 78s. Instead, the user may have to adjust the speed to somewhere between 72 RPM and 85 RPM in order to obtain the correct pitch.

Our new preamplifier in last month's issue has been designed so that you can select the correct curve for your application.

## The turntable

Your turntable should be equipped with a magnetic pick-up cartridge and have 45 RPM and 33 RPM speed settings. To play 78 RPM recordings, you will need a cartridge that accepts the correct stylus (more on this later) and your turntable will need a 78 RPM speed setting as well.

Note that some recording software packages include RIAA and other equalisation curves. However, don't try connecting the cartridge output directly to the computer and then relying on the software for the RIAA equalisation – the 10mV (typical) signal level from a cartridge is far too low to produce good results. You must use

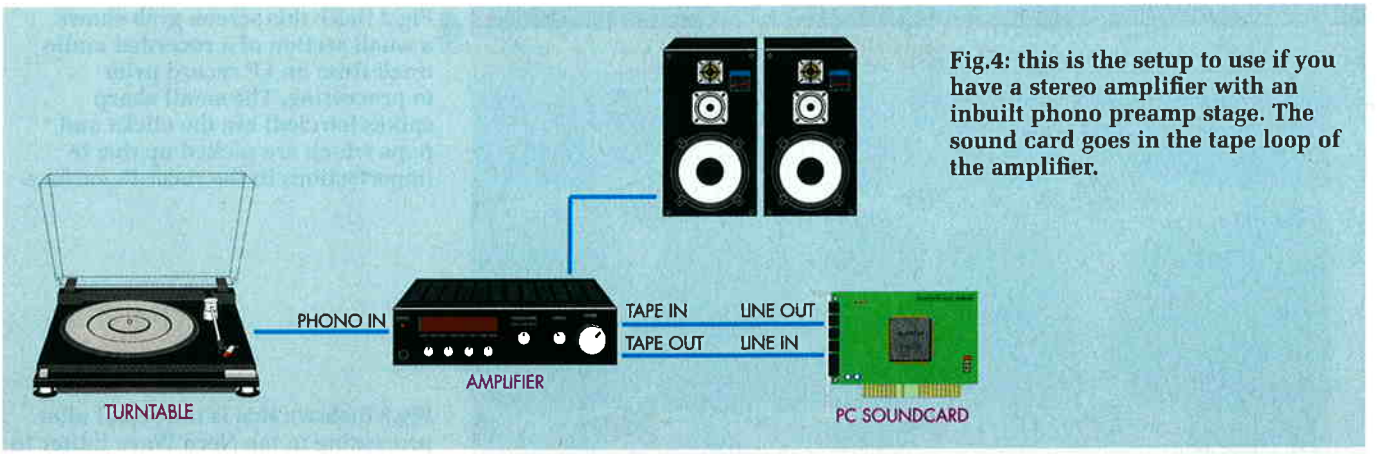



**Fig.4: this is the setup to use if you have a stereo amplifier with an inbuilt phono preamp stage. The sound card goes in the tape loop of the amplifier.**

a preamplifier to boost the signal and provide the required equalisation.

By the way, if you are using an amplifier with an inbuilt RIAA preamplifier, the signal for the computer can be derived from the Tape Out sockets.

In any case, make sure that the line input volume level is turned up. This is done in Windows XP by accessing Start/Control Panel/Sounds and Audio Devices/Audio and under sound recording select Volume – see Fig.6.

## Basic checks

Before playing a record, check that the stylus is in good condition and is dust-free. Check also that the tracking weight and the anti-skating adjustment are correct.

The record surface should be cleaned with an anti-static cloth to ensure it is lint free. Having done that, try playing a standard LP record and monitor it via your PC's loudspeakers.

Note that some computers and some CRT monitors may interfere with the audio signal. If that happens, try moving the turntable and preamplifier further away from the computer.

If you encounter lots of mains hum, try earthing the turntable. Some turntables have an earth wire that must be connected to an earth – either a signal earth or a mains earth. In the first instance, try connecting the earth lead from the turntable to the earth binding post on the SILICON CHIP preamplifier. If this doesn't cure the hum, then the turntable may need a mains earth.

If you are using a computer that has an earthed metal case, try connecting it to the banana socket on the preamplifier. If you have a laptop computer, try using an earthed plugpack such as the Jaycar MP-3022 with a 5-pin DIN line plug connected to its output lead. Wire the earth lead to the centre pin of the DIN plug and each low-voltage AC lead to the outer two pins as shown in Fig.4 in last month's preamplifier article. Of course, you will also have to install the 5-pin DIN socket on the preamp's PC board.

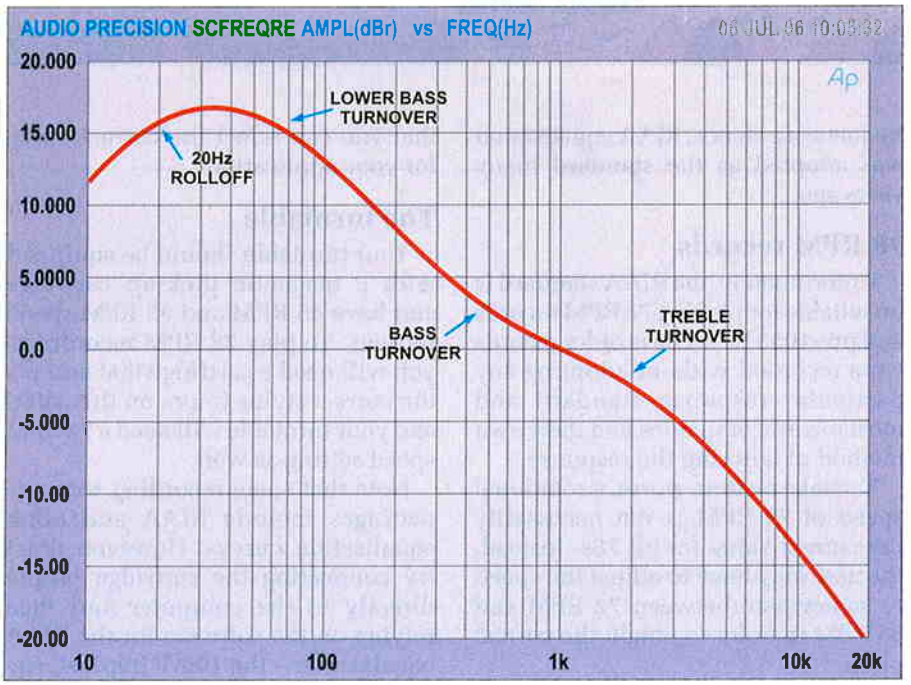



**Fig.5: the RIAA equalisation curve. During playback, the bass frequencies are boosted and the treble cut to compensate for the recording characteristics.**

## Recording

The recording can be made using either a PC or an MP3 player that has a line input socket. The advantage of using a computer is that the signal can be cleaned up to remove the noise from the signal.

To record to a computer, you will need suitable recording software plus a CD burner if you wish to later burn the recording to a CD. If your computer has Nero installed, then you can use Nero Wave Editor (Start\All Programs\Nero Burning ROM\Nero Wave Editor) to record. If you don't have any recording software, you can download a package from the internet. For example, NCH's Swift Sound Wave Pad (**www.nch.com.au/wavepad/**) provides a trial version of their WavePad Masters Edition software package. It includes noise reduction, click and pop removal and CD burning software all in one package (note: we found that the automatic click and pop removal in WavePad 3.02 was not successful although it may be improved in later versions. Manual click removal worked well, however).

Alternatively you can try the DC Art Millennium restoration software (available as a trial for 10 days) from **http://**

**Fig.6: be sure to turn up the volume for the line input.**

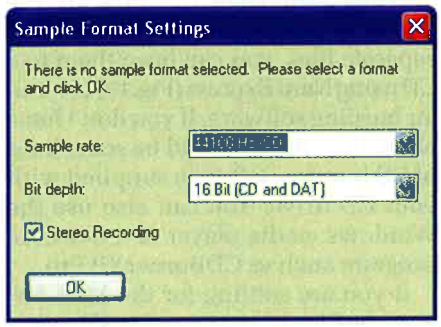

Sample Format Settings
There is no sample format selected. Please select a format and click OK.
Sample rate:
Bit depth:
16 Bit (CD and DAT)
Stereo Recording
OK

**Fig.7: when recording, select the standard 44.1kHz sample rate and 16-bit depth.**

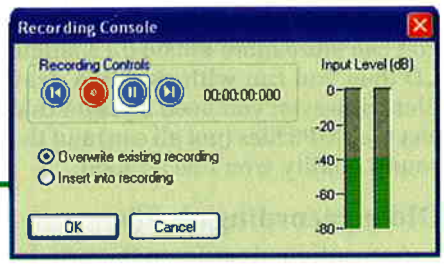



**Fig.8: set the recording level for good signal strength without clipping.**

**www.enhancedaudio.com/record_restoration.htm**. The software packages are relatively easy to use and they all use menus and icons that are similar in operation.

Note that you may want to use more than one package to obtain all the features you want. For more information, take a look at the LP Restoration article in the January 2001 issue of SILICON CHIP. The software descriptions and comments are still relevant today, although the screen shots show older versions of the software.

## Using Nero Wave Edit

To begin a recording select Audio\Record, then select the recording quality. For a normal recording, choose the standard 44.1kHz sample rate with 16-bit depth (Fig.7).

Next, set the recording level so that it doesn't clip. It's simply a matter of setting the level control on the preamplifier so that level indicators show sufficient signal level – see Fig.8.

Once a track has been recorded, you can remove the noise and any clicks and pops using the Enhancement\Declicker feature – Fig.9. To do this, select the file by first right-clicking your mouse at the start of the recording and dragging the cursor (or click the "select all" icon), then select the Declicker and Noise Reduction features which are located under Enhancement.

If necessary, you can alter the parameters for the declicker and decrackle features using the dialog shown in Fig.10. These include the threshold level and maximum length. The default settings generally work fine but you may need to experiment when a record has severe clicks and pops.

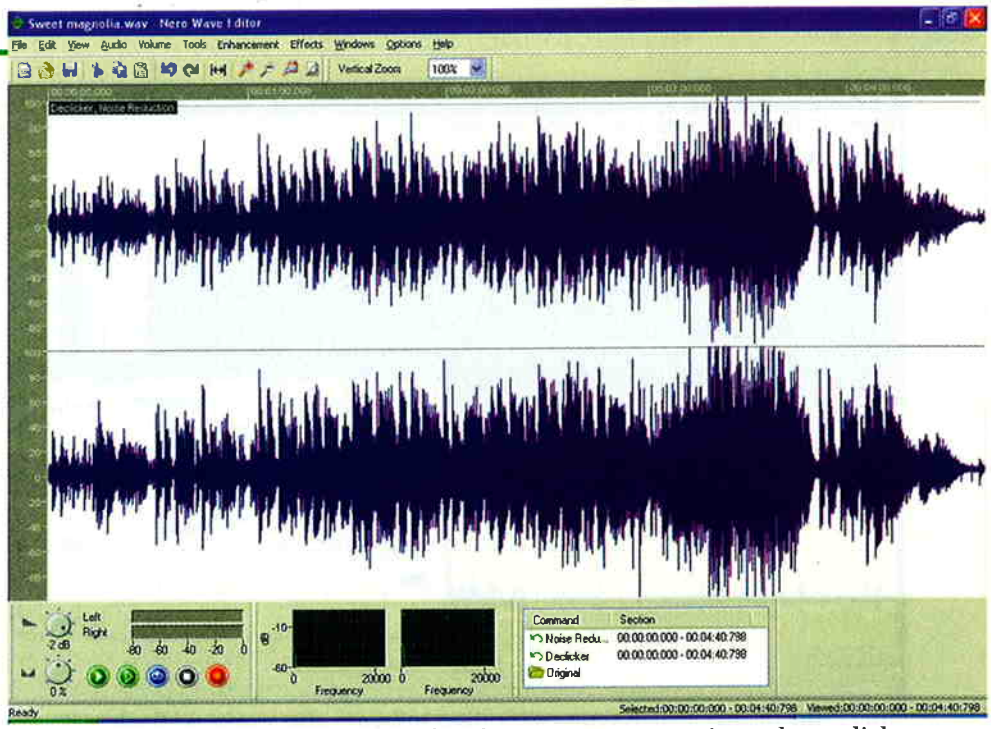



**Fig.9: use Nero's Enhancement\Declicker feature to remove noise and any clicks and pops from the recorded signal.**

We found that the DC Art Millennium restoration software also works well when it comes to removing clicks and pops from records. In this case, the "Impulse" filter removes clicks, while the "Median" filter removes crackles. The authors also recommend reversing the file (select Effects\Reverse File) and re-running the Impulse filter for best click removal results. The file then needs to be reversed again, to restore the original direction.

Fig.11 shows the original "wav" file (grey background waveforms) after a recording from an LP record. The lower waveforms on the yellow background show the effect of passing the recording through the Impulse filter. As shown, the clicks have been removed.

If necessary, stubborn clicks can be manually removed if they are still there after using the automatic mode.

Another sound editing software package called Audacity is available

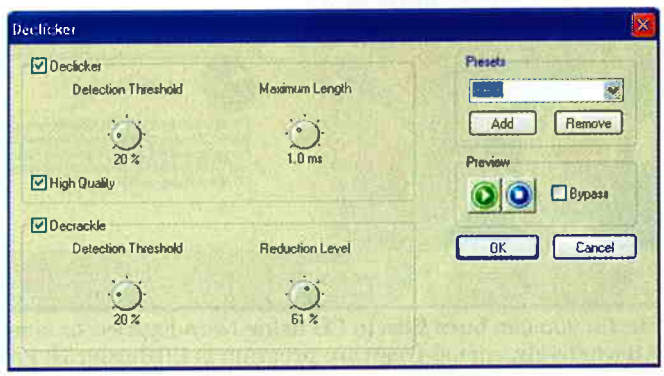



**Fig.10: the default declicker and decrackle settings generally work fine in Nero but you can also set them manually if the record has severe clicks and pops.**

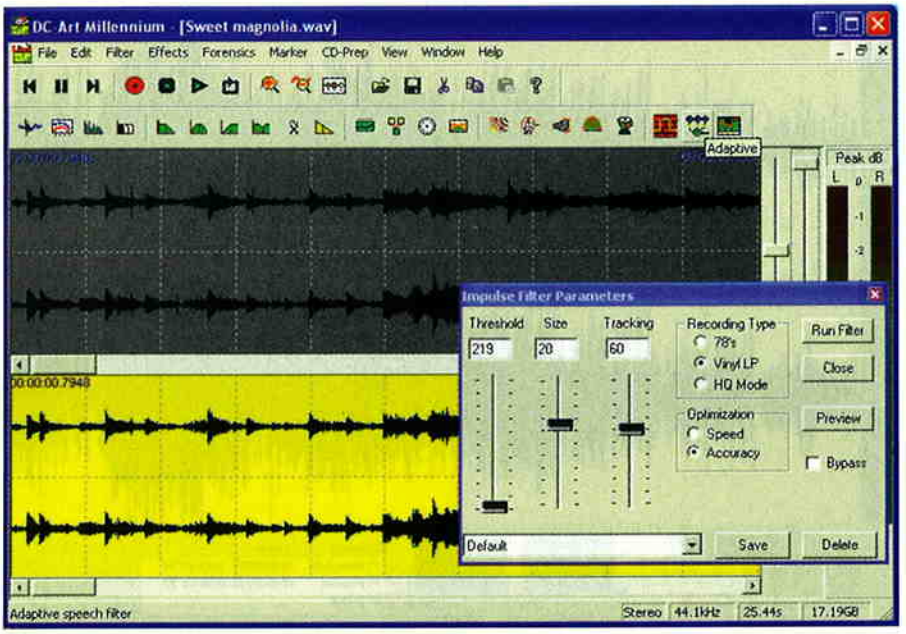



**Fig.11: the DC Art Millennium restoration software also works well when it comes to removing clicks and pops from records.**

**Fig.12: select 44.1kHz and 16-bit when saving files in wav format.**

free from **http://audacity.sourceforge.** net/. It also includes click removal and filter tools, making it suitable for restoring damaged recordings.

Following click removal, you can do further processing such as noise removal, hiss removal and equalisation (for equalisation, see the section concerning 78 recordings). Noise reduction is made by referencing the noise level to a "silent" part of the recording and then running the noise reduction feature.

Once you are happy with the results, the file can be saved in the standard CD wav format of 44.1kHz and 16-bit (Fig.12). Alternatively, files can be saved in the MP3 format.

## Bit rates

There are several bit rates to choose from when making an MP3 file. These range from 320kb/s with a 4:1 compression) down to 96kb/s. For music, select at least 192kb/s or preferably 256kb/s (6:1 compression), or 320kb/s for the highest quality. Of course, the higher the bit rate, the bigger the file and the lower the number of tracks that can be stored on an MP3 player.

Other formats include AAC (or MP4) format and this produces a further improvement over MP3 encoding. As before, select the higher bit rates for best sound quality. Some MP3 players such as the Apple iPODs will also accept the MP4 format.

Incidentally, a .wav file has a 16-bit x 44.1kHz x 2 (for stereo) sampling rate. This corresponds to a 1411.2kb/s rate and gives some idea why .wav files are superior to MP3s.

When you have restored all the tracks on the LP and saved them into separate files, you can burn them to a CD using Nero Express (Fig.13) or similar burning software. If you don't have Nero, then there should be some kind of CD burning software supplied with your CD drive. You can also use the Windows media player or a freeware program such as CDBurnerXP Pro.

If you are settling for the MP3 format, the files can be transferred to your MP3 player or Apple iPOD. You could also burn them onto a CD as an MP3 disc (this disc format can also be processed with Nero Express). In this way, you can store more music on a single CD than you can with standard .wav files. However, you need a player that can play MP3 files (not all can) and the sound quality won't be as good.

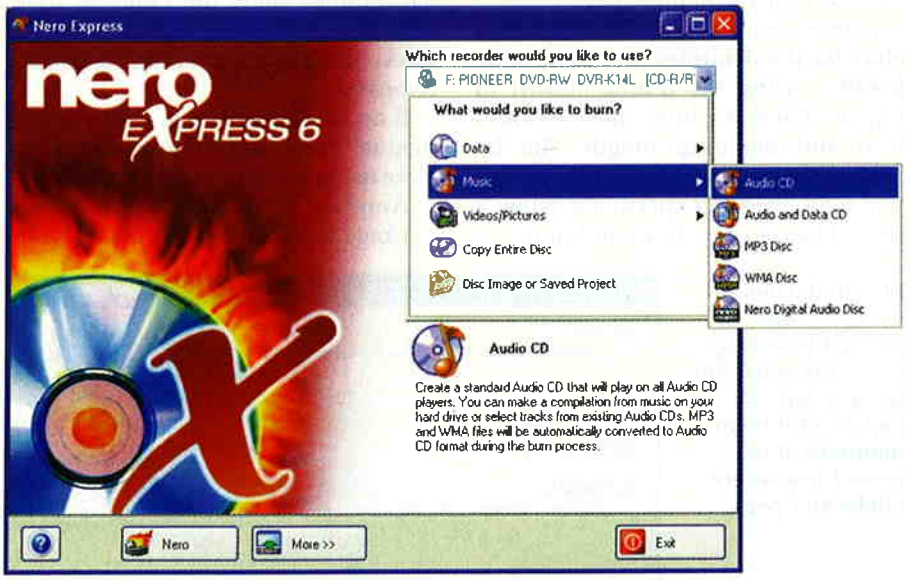

Nero Express
nero EXPRESS 6
Which recorder would you like to use?
F: PIONEER DVD-RW DVR-K14L (CD-R/R
What would you like to burn?
Data
Music
Videos/Pictures
Copy Entire Disc
Disc Image or Saved Project
Audio CD
Audio and Data CD
MP3 Disc
WMA Disc
Nero Digital Audio Disc
Audio CD
Create a standard Audio CD that will play on all Audio CD players. You can make a compilation from music on your hard drive or select tracks from existing Audio CDs. MP3 and WMA files will be automatically converted to Audio CD format during the burn process.
Nero
More >>
Exit

**Fig.13: you can burn files to CD using Nero Express or similar burning software. Alternatively, a good freeware program is CDBurnerXP Pro.**

## Older recordings & 78s

As mentioned earlier in this article, the RIAA response curve is not suitable for older (pre-1955) recordings. However, if the you build the preamplifier described last month, you can choose the equalisation required to suit your LPs and 78s.

For microgroove LPs (33 RPM) and 45 RPM records, choose "ffrr LP" for pre-1955 English Decca LPs; "EMI LP" for pre-1955 HMV and English Columbia LPs; "Columbia" for older American Columbia LPs; and "NARTB" for some early American labels.

If you are unsure of the equalisation required, select the RIAA curve. You can then later equalise the sound using a software equaliser. Adjust the response until you are happy with the results (Fig.14).

Note that it's best to use a preamplifier that has the correct response for the recording already built in, rather

than rely solely on software. This will provide the best signal-to-noise ratio and the lowest distortion. Any equalisation that you subsequently apply later on then only has to make relatively minor changes that do not involve large signal level shifts.

To play 78s, you will require a 3-mil (.003-inch) stylus (the Stanton 500 cartridge can be supplied with a 3-mil stylus) and a preferably a turntable that will run at 78 RPM. Note that some DJ turntables have an add-speed function, whereby pressing both the 33 RPM and 45 RPM selections sets the speed at 78 RPM. A turntable with pitch control is even better.

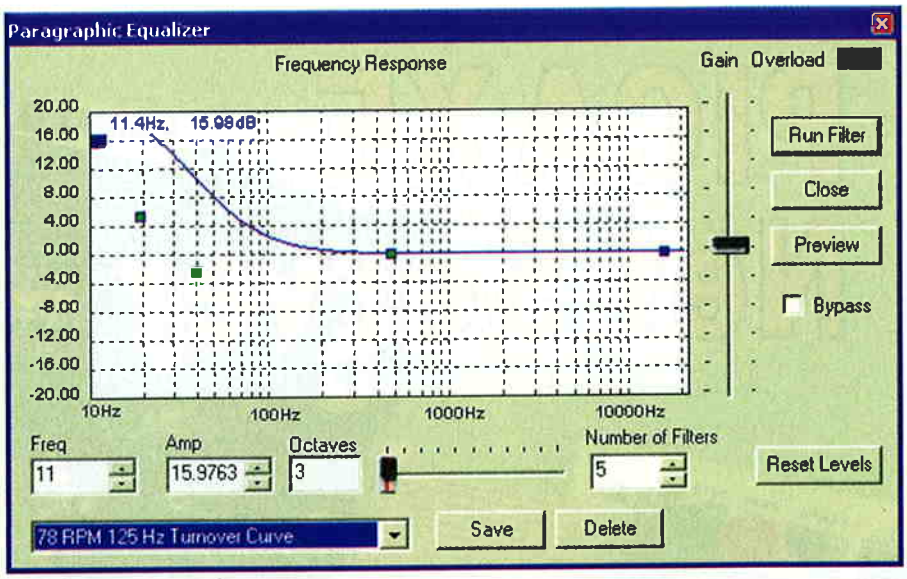
Alternatively, provided you are using the correct stylus, you can play the record at 45 RPM and change the playback speed after recording in the software. However, this manner of recording will also affect the equalisation because all the frequencies from the record will be lower. This will have to be corrected by adjusting the software equalisation.

When playing 78s at 78 RPM, use these equalisation curves: "WESTREX" (English Western Electric) for HMV 78s that have a triangle matrix code and English Columbia 78s with a matrix code; "BLUMLEIN" for HMV records with a square adjacent to the matrix number, for English Columbia 78s with a (c) symbol and for HMVs that have no code and are dated from 1945 up to about 1953; and "BSI 78" for all post 1953 78s.

If playing a 78 record at 45 RPM, select an equalisation curve that has a lower bass and treble turnover frequency than the one that should be used. For example, if the ffrr 78 curve applies at 78 RPM, select the Decca 78 curve for 45 RPM instead. This curve has a lower turnover frequency for both bass and treble and would match the lower frequencies experienced when playing at the slower speed.

If you are unsure of the equalisation that needs to be used, try recording using two different equalisations (eg, the Decca 78 and Westrex equalisations), then choose the one that sounds the best. Final tweaking can then be done using a software equaliser (Fig.15).

Note that some 78s will sound off pitch. In this case, you can adjust the pitch using the recording software (Fig.16). Similarly, if the recording was made at 45 RPM, adjust the playback speed to 173% (Fig.17). **SC**



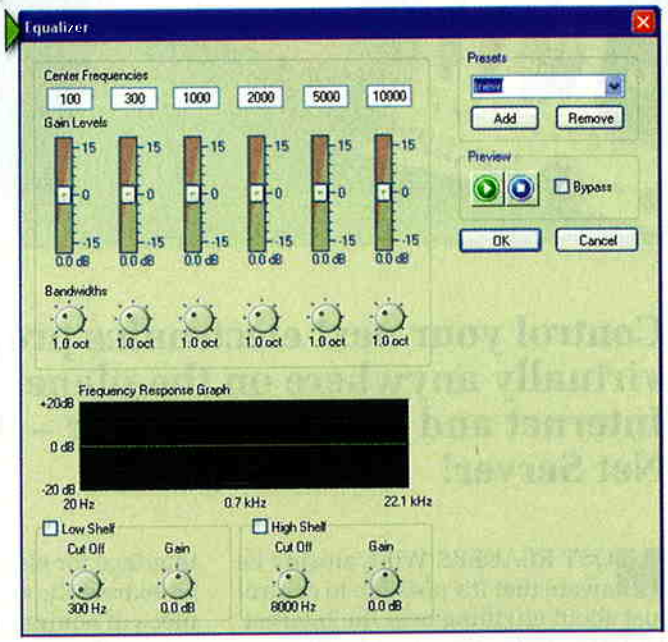




**Fig.14 & 15: software equalisers can be used to adjust the equalisation and to enhance the sound if necessary.**

**Fig.16: recordings that sound off-pitch can be corrected using Nero's "Pitch Change" adjustment.**

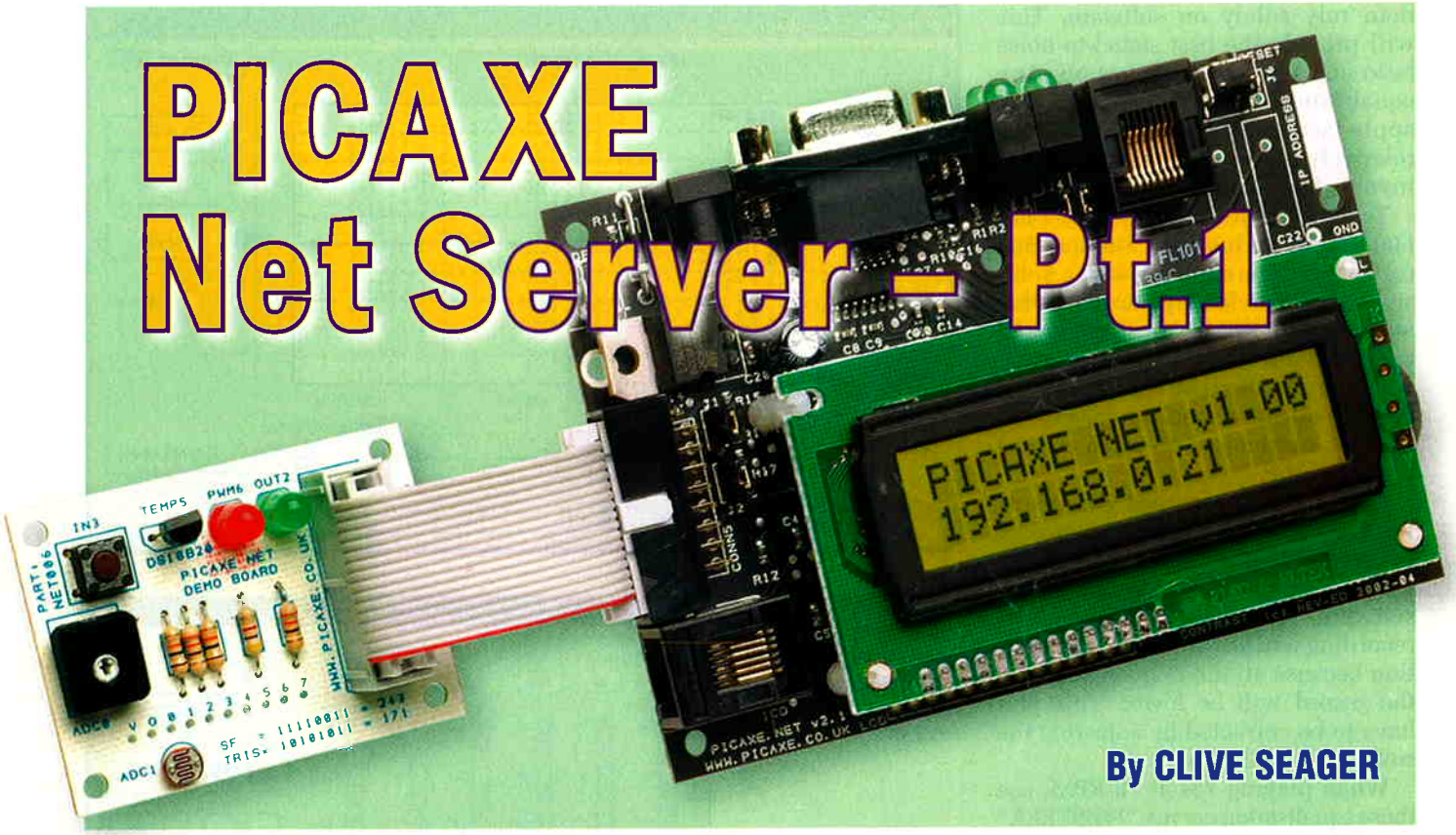
**Fig.17: the "Speed Change" feature is useful for correcting 78s that were recorded at 45 RPM (ie, use 173%).**

## What About Copyright?

Transferring copyright music and other copyright material from one format to another is currently illegal in Australia. In other words, it is illegal to transfer the recording of an LP to a CD or from a CD to an MP3 player. To obtain permission to do this, you must contact the recording company that holds the copyright for each recording you wish to transfer.

This copying restriction does not apply if the copyright has expired. It is expected that this law is about to change in Australia to allow copying of already purchased copyrighted material to other media for your own personal use under certain circumstances.

# PICAXE Net Server – Pt.1




By CLIVE SEAGER

## Control your next electronics project from virtually anywhere on the planet using the Internet and a tiny web server – the PICAXE Net Server!

MOST READERS WILL already be aware that it's possible to control just about anything over the Internet. Unfortunately, the complexities involved in doing so mean that simple do-it-yourself projects are locked out of this extremely useful technology – until now, that is!

The PICAXE Net Server (PNS) described here is a microcontroller-based web server, designed to operate either by itself or in partnership with a PICAXE chip. This small (112 x 76mm) board acts as a complete stand-alone web server, without the need for a computer, making it ideal for building into electronics projects.

Because the PNS is microcontroller based and reads its web pages from a small memory chip (EEPROM), it obviously cannot act as a conventional web server, serving thousands of pages to hundreds of users. However, when used appropriately as an Internet interface for electronics projects, it is an extremely versatile and powerful piece of equipment.

Over the coming months, we'll look at using the PICAXE Net Server in a couple of simple projects. This month, we'll look at the basics of the PNS and then construct a simple demo board to connect to its input/output port. The remainder of the article focuses on setting up the PNS and culminates in the use of the demo board for testing.

### What you need

It is recommended that first-time users of this system purchase the PICAXE Net Starter Pack. The pack includes the PNS itself, the Net Demo board and a Protoboard with a PICAXE-28X chip installed (see "Obtaining Kits & Software" elsewhere in this article). Also included are the required serial download and network cables. The PNS and Protoboard are supplied fully assembled, whereas the Net Demo board is supplied as a kit for user assembly.

You will also need to purchase a 9V DC 1A power supply separately (eg, a plugpack) if you don't have one.

Note that although it's possible to set up and test the PNS without a network, you can't do much more than that unless you have (at minimum) a fully functioning small home network with an Internet connection.

Future instalments will describe the network setup in some detail, including how to make the PNS visible on the Internet. However, due to the huge variation in networking products, we cannot hope to cover all possible configurations. You should therefore have at least a basic knowledge of Microsoft Windows networking or be able to obtain assistance from someone who has if necessary.

**Before continuing, make sure you have upgraded your PICAXE Programming Editor software to version 4.1.16 (or later).** The software updates are available to download free of charge from **www.picaxe.co.uk**.

### The PNS circuit

A block diagram of the PICAXE

| Table 1: PNS Input/Output Port | |
|---|---|
| **Pin** | **Special Function** |
| P7 | input - mode switch |
| P6 | output - PWM output |
| P5 | input - DS18B20 digital temperature sensor interface |
| P4 | output - LED tick output |
| P3 | input - ADC3 |
| P2 | input - ADC2 |
| P1 | input - ADC1 |
| P0 | input - ADC0 |

Net Server appears in Fig.1. At the heart of the system is a PIC18F452 microcontroller, programmed with the PNS firmware. The micro connects to the network via an RTL8019 Ethernet controller chip.

Time and date are maintained by a battery-backed DS1307 real time clock (RTC) chip, while the web pages are stored in a 24LC512 EEPROM. The PNS also includes a serial interface, a general-purpose input/output port and a 2-line, 16-character LCD.

A photograph of the PNS appears in Fig.2, highlighting the positions of the various connectors, LEDs and switches. Note that the LEDs between the serial and network connectors are stacked two high to maximise on real estate.

The LEDs next to the network connector indicate network status, the top LED lighting when the PNS is correctly connected to a network. The bottom LED is also normally illuminated but flickers while network communications are in progress.

Of the other two LEDs, the upper device connects to the RTC chip and flashes once per second. The lower LED connects to the output port (P4) and can be used within a program as a status indicator. Alternatively, it can be configured as a "heartbeat" signal, flashing every second to show that the PNS firmware is operating normally.

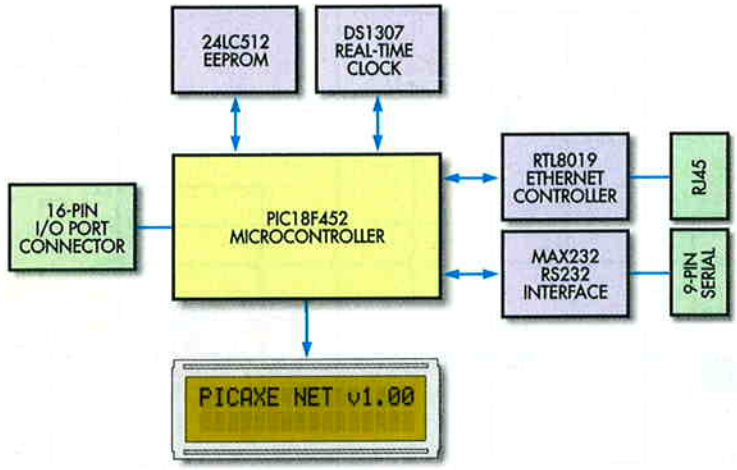



**Fig.1: the PICAXE Net Server is based around a PIC18F452 microcontroller from Microchip. Compressed web pages are stored in a tiny 64kbyte EEPROM, while a 2-line, 16-character LCD conveys status information and can display user-programmed messages. The network connection is handled by a Realtek RTL8019 Ethernet controller chip.**

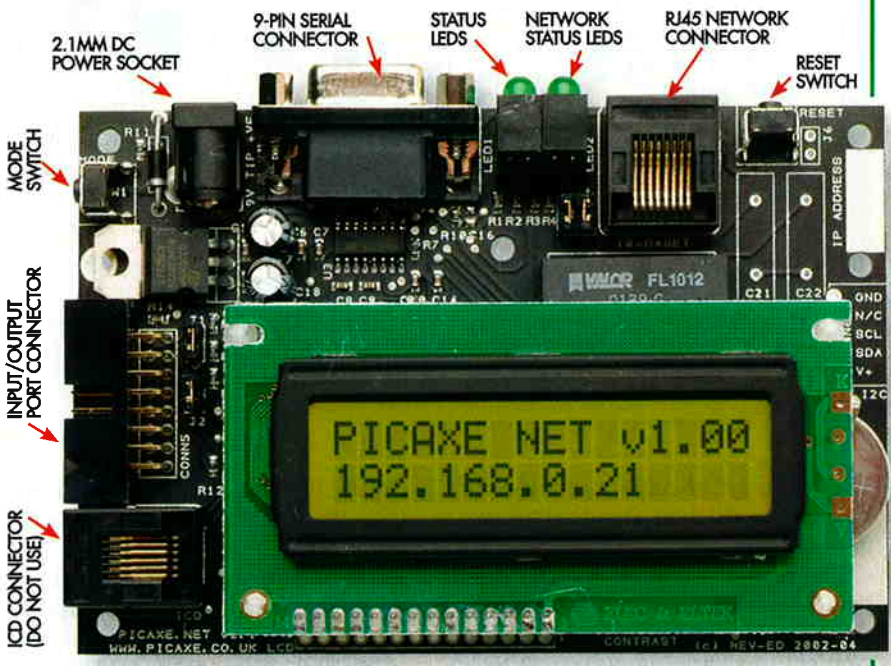



**Fig.2: the PNS is supplied fully assembled. Most of the electronics is hidden beneath the LCD module, which sits atop 12mm standoffs. All connectors are positioned along the extremities of the PC board for easy access. The ICD (in-circuit debugging) connector is for factory programming, so don't connect anything to it!**

## I/O port

The PNS has an 8-bit general-purpose input/output (I/O) port, accessed via a 16-pin IDC header (CONN5). Under software control, each pin is individually configurable as a digital input or output. Each pin also has an associated special function, as listed in Table 1.

When configured as outputs, all pins have a maximum sink or source current of 20mA. An exception to this is output 4, which is open collector and so can only sink current.

In operation, the I/O pins are controlled via two 8-bit registers in the PNS named "TRIS" and "SF". A zero in any bit of the TRIS register causes the corresponding pin to act as an output, whereas a one causes it to act as an input. Setting an SF bit to one enables the corresponding pin's special function, while a zero disables that function.

## Demo board assembly

The PICAXE Net Demo board is designed to allow initial testing of the PNS input/output port. It's sup-

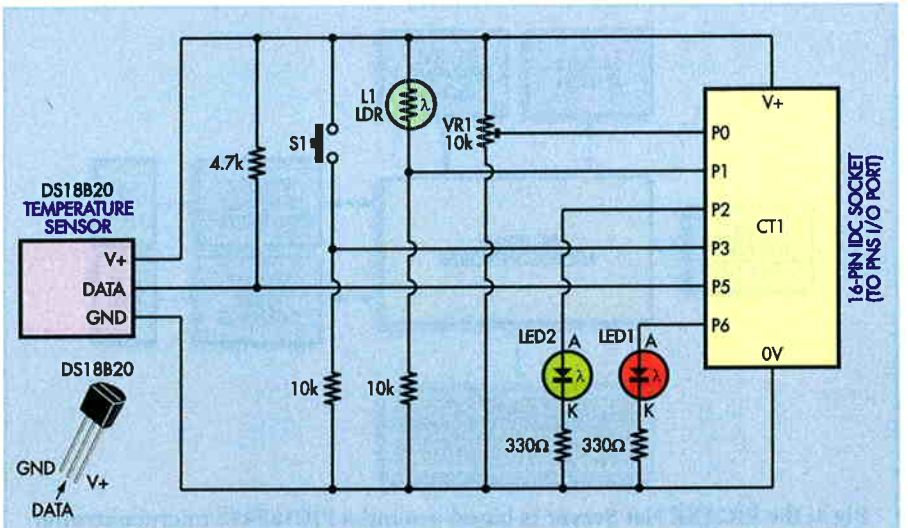



**Fig.3: the Net Demo board provides a means of connecting a group of peripheral devices (a switch, LDR, temperature sensor and two LEDs) to the PNS input/output port for testing.**

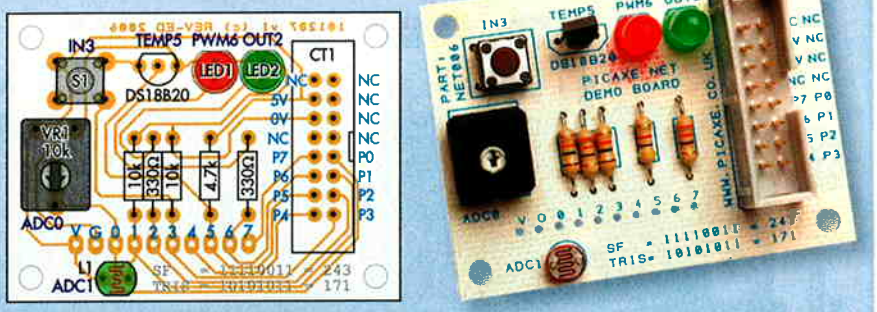



**Fig.4: follow this diagram when assembling your Net Demo board. Take care with the orientation of the DS18B20, the LEDs and the I/O connector (CT1). The view at right shows the full-assembled board.**

plied as a kit of parts and shouldn't take you more than about 10 minutes to assemble.

The circuit diagram for the demo board appears in Fig.3. As you can see, pins P0, P1 & P5 of the PNS port connect to a variable voltage (VR1), a light sensor (LDR) and a temperature sensor (DS18B20), respectively. In addition, P3 connects to a switch, while P2 & P6 drive red & green LEDs (P4 is not used).

Refer to the overlay diagram in Fig.4 for component placement. In particular, ensure that the flat (cathode) sides of the two LEDs and the DS18B20 temperature sensor are oriented as shown. Also, ensure that the notched side of the 16-pin IDC connector is oriented correctly. If you follow Fig.4 and the markings on the PC board, you can't go wrong!

Once assembled, set trimpot VR1 to about mid-position and connect the board to the PNS using the 16-way ribbon cable assembly supplied in the starter pack. Note that a row of holes (currently unused) is provided for the connection of experimental test circuits, if desired.

The TRIS and SF registers in the PNS must now be set up to suit the input/output devices present on the board. Using the information in Table 2, we can deduce that the registers should be set as follows:

**TRIS = %10101011 = 171**
**SF = %11110011 = 243**

This month, we will set these register values automatically via a default web page already programmed in the PNS. In future articles, we'll look at other ways to set these values and create our own custom web pages for the PNS. In the meantime, let's continue with the initial PNS setup procedure.

## Setting up the PNS

The PNS setup procedure varies slightly depending on how your home network is configured. Generally, it's a 4-step process, so let's examine each step in turn.

### STEP 1: Connect The Network Cable

There are two possible ways to connect the PNS to your computer to perform the initial setup and testing:

**(a) Connection via a hub/switch/router (recommended)**

If your computer is part of a home network, it will probably be connected to a small hub, switch or router. In this case, use an ordinary ("straight-through") network cable (coloured blue in the Starter Pack) to connect the PNS directly to a spare port on your network hub/switch/router. Make sure that the device supports "10-BASE T" connections; devices marked as "10/100" are compatible.

**(b) Direct connection**

If your computer is not connected to a network, then it can be connected directly to the PNS. Of course, this assumes that your computer includes a "10-BASE T" compatible networking socket.

To make the connection, simply use the "crossover" cable (coloured grey in

**Table 2: PNS Setup For Net Demo Board**

| Pin | TRIS | SF | Demo Board Use |
|---|---|---|---|
| P7 | Input | PNS mode switch | *not connected* |
| P6 | Output | PWM output | LED |
| P5 | Input | Temperature | DS18B20 temperature sensor |
| P4 | Output | PNS 'tick' LED | *not connected* |
| P3 | Input | -- | push switch |
| P2 | Output | -- | LED |
| P1 | Input | ADC1 | Light Dependant Resistor |
| P0 | Input | ADC0 | Preset Resistor |

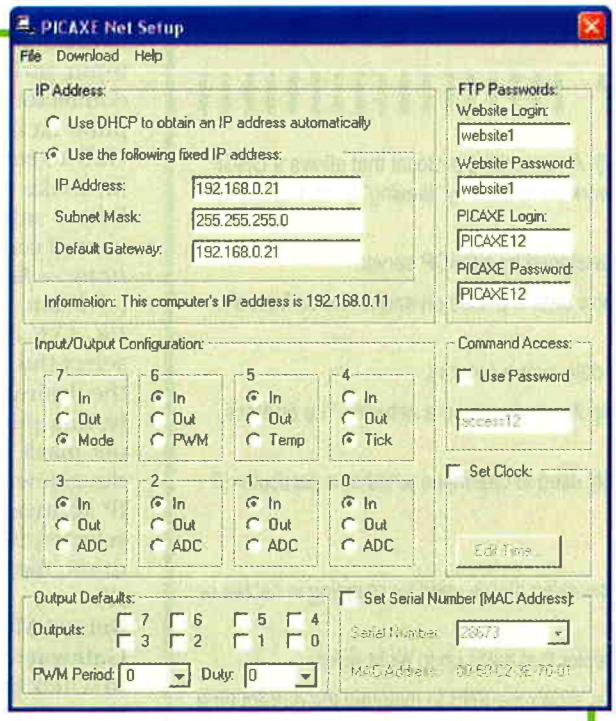



**Fig.5: if your network uses fixed IP addresses, then you need to manually assign an IP address to the PNS before use. This is achieved via the Programming Editor's "PICAXE Net Setup" wizard, as depicted here.**

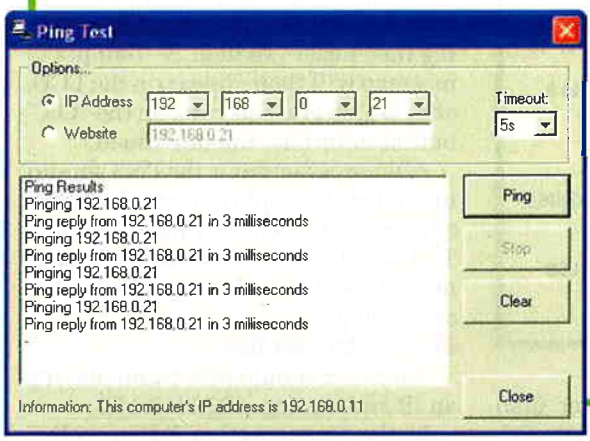



**Fig.6: a "ping" test is a quick way of verifying that the PNS is contactable over the network. You'll note that we've used an address of 192.168.0.21 for the PNS in these examples, rather than 192.168.0.11 as described in the text. Either should work on a small home network!**

the Starter Pack) to connect the PNS to your computer's network connector.

### STEP 2: Connect A 9V DC Plugpack

Connect a 9V DC plugpack (2.1mm tip, centre positive) to the DC input socket. When power is applied, the LCD should display "PICAXE NET v1.00". If you don't see this message or it is very faint, try adjusting the LCD contrast setting using the vertical trimpot at the front of the PNS.

When the PNS has a working network connection, the top LED (next to the network connector) will light.

### STEP 3: Set The PNS IP Address

All devices connected to a network, including the PNS, require a unique IP address for identification.

As supplied, the PNS is configured to automatically receive an IP address from the network. In this mode, the DHCP server (eg, your router) allocates the PNS an IP address as soon as it connects to the network. If your network supports DHCP, the IP address (eg, something like 192.168.0.5) will appear on the PNS LCD screen a few seconds after a successful network connection is established. In this case, you can skip directly to Step 4!

If you have connected the PNS directly to the computer via the crossover cable or if no IP address automatically appears on your PNS LCD, then your network is using fixed IP addresses. In this case, you must manually assign a fixed IP address to the PNS.

At this point, it is useful to know the IP address of your computer. To discover the address, run the Programming Editor software and then choose the *PICAXE -> Wizards -> PICAXE Net Server -> Ping Test* menu. The computer's IP address will be displayed

## Parts List: Net Demo Board

1 PC board
1 16-way IDC connector (CT1)
1 miniature tactile pushbutton switch (S1)
1 miniature 10kΩ trimpot (VR1)
1 miniature LDR

**Semiconductors**
1 DS18B20 1-wire digital temperature sensor
1 5mm red LED (LED1)
1 5mm green LED (LED2)

**Resistors (0.25W 5%)**
2 10kΩ
1 4.7kΩ
2 330Ω

### Obtaining kits and software

The PC board copyright for this project is owned by Revolution Education Ltd. A complete NET001 Starter Pack is available from authorised PICAXE distributors – see **www.microzed.com.au** or phone MicroZed on 1300 735 420. Each Starter Pack contains:

1 NET002 PICAXE Net Server
1 NET006 PICAXE Net Demo Board kit (as listed above)
1 CAB010 RS232 serial cable
1 CAB005 CAT5 patch cable (blue)
1 CAB006 CAT5 crossover cable (grey)
1 AXE022P PICAXE-28X Protoboard
1 AXE010X PICAXE-28X microcontroller (preinstalled on above Protoboard)
1 NET004 16-way IDC ribbon cable assembly

### Also required (not in Starter Pack)

1 9V DC plugpack with 2.1mm plug, centre positive

**Optional items**
1 USB010 USB to serial adapter
1 HUB001 5-port 10/100 Ethernet switch
1 CAB005 CAT5 patch cable (for use with switch)

**Optional add-ons**
SPE020 Speech synthesizer
MIC052 PCF8570P RAM

## Jargon Buster

**DHCP (Dynamic Host Configuration Protocol):** A networking protocol that allows a DHCP server to assign temporary IP addresses to network computers by "leasing" IP addresses to users for a limited amount of time.

**Dynamic IP Address:** A temporary IP address assigned by a DHCP server.

**Ethernet:** A networking protocol that specifies how data is placed on and retrieved from a common transmission medium.

**IP (Internet Protocol):** A protocol used to send data over a network.

**IP Address:** The address used to identify a computer or device on a network. The address can be static (fixed) or dynamic (changing).

**Ping (Packet INternet Groper):** An Internet utility used to determine whether a particular IP address is online.

**PNS:** PICAXE Net Server

**Port:** The connection point on a computer or networking device used for plugging in cables or adapters.

**RJ-45 (Registered Jack-45):** An Ethernet connector that holds up to eight wires.

**RTC (Real Time Clock):** an integrated circuit that allows the PNS to maintain the current time and date.

**Server:** Any computer whose function in a network is to provide user access to files, printing, communications and other services.

**Static IP Address:** A fixed address assigned to a computer or device that is connected to a network.

**Subnet Mask:** An address code that determines the size of the network.

**TCP (Transmission Control Protocol):** A network protocol for transmitting data that requires acknowledgement from the recipient of data sent.

**TCP/IP (Transmission Control Protocol/Internet Protocol):** A set of instructions PCs use to communicate over a network.

at the bottom of the "Ping Test" window. If the number is 0.0.0.0 then no IP address is currently set up on your computer.

Next, you need to select an IP address for the PNS. If you are familiar with IP addresses, you have probably already nominated a suitable number and so can proceed directly.

Alternatively, a good rule of thumb for home networks is to select an address that is about 10 larger than your computer's current address. For example, if the computer's IP reads 192.168.0.1, then try 192.168.0.11 for the PNS. The important point here is that no two devices on the network must be using the same address!

Now that you've selected an IP address, it must be programmed into the PNS, as follows:

(a) Connect the serial cable (supplied in the Starter Pack) between your PC's 9-pin serial port and the serial port connector on the PNS. If your computer lacks a serial port, you'll need a USB-to-serial adapter.

(b) Make sure that the Programming Editor software is set up to use the correct serial port via the *View -> Options -> Serial port* menu.

(c) From the *PICAXE -> Wizards -> PICAXE Net Server -> Setup* menu, select the "Fixed IP" option and enter the desired IP address (see Fig.5). For testing purposes, make sure the subnet mask is set to 255.255.255.0 and the gateway is set to the same as the IP address. For example, if you have selected 192.168.0.11 as the PNS IP address, the correct settings would be:

| | |
|---|---|
| **IP:** | **192.168.0.11** |
| **Subnet Mask:** | **255.255.255.0** |
| **Gateway:** | **192.168.0.11** |

(d) Click on "Download" and a dialog box will appear with further instructions. Briefly, you must now press and hold the "Mode" switch while pressing the "Reset" switch. A "Setup. . ." message will then appear on the LCD, after which you can click on the "OK" button to initiate the download.

After programming, the PNS should immediately display your selected IP address on the bottom line of the LCD. The serial cable can now be disconnected, as it is only required for the above steps.

### STEP 4: The Ping Test.

Your PNS should now be displaying an IP address (eg, 192.68.0.11).

In the Programming Editor, select the PICAXE -> Wizards -> PICAXE Net Server -> Ping Test menu. Enter the IP address (as shown on the LCD) and then click "Ping".

If the system is set up correctly, you should see a series of four replies on the screen almost instantly - similar to the example shown in Fig.6. This proves that your computer can "talk" to the PNS over the network.

Note: the first time you use the Programming Editor software with the PNS you may get a warning message if you are running an Internet security/firewall application. This is completely normal. You simply need to ensure that your firewall software allows the Programming Editor executable file (progedit.exe) to communicate on ports 80 (HTTP) and 21 (FTP).

In the case of the Norton Internet Security (see Fig.7), choose "Permit" and "Always use this action" to prevent

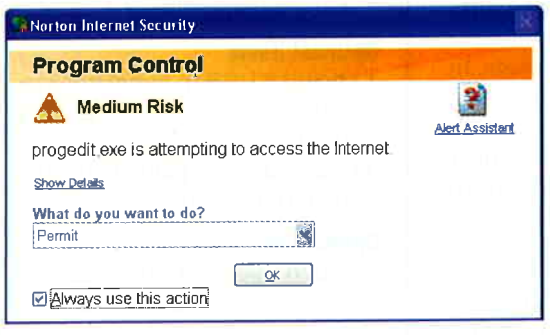



**Fig.7: some Internet security/firewall packages may prevent the PICAXE Programming Editor (progedit.exe) from accessing the Internet. Here's the warning message given by one popular package. In this case, choose "Permit" and "Always use this action" to allow access.**

the message appearing again in the future. Note that if you do not correctly configure firewall/security access, the Programming Editor software will be prevented from communicating with the PNS.

### STEP 5: View The PNS Web Pages Using A Browser

Open your web browser and enter the IP address shown on the PNS screen as the website address (eg, http://192.168.0.11). The default home page of the PNS should then be displayed - see Fig.8.

A click on the netdemo.cgi link should then take you to the demo page for the PNS Net Demo board (Fig.9). Make sure the demo board is connected to the PNS and then click the "Setup SF/TRIS" button at the top of the page. This configures the TRIS and SF registers of the PNS to match the demo board layout, as described earlier.

Now click the "Switch LED on" button. If all is well, the LED on the demo board should light up! So there, you have it – control of devices over a network from an Internet browser! OK, so the PNS is probably sitting on the desk in front of you at the moment but in theory you can control it from anywhere in the world!

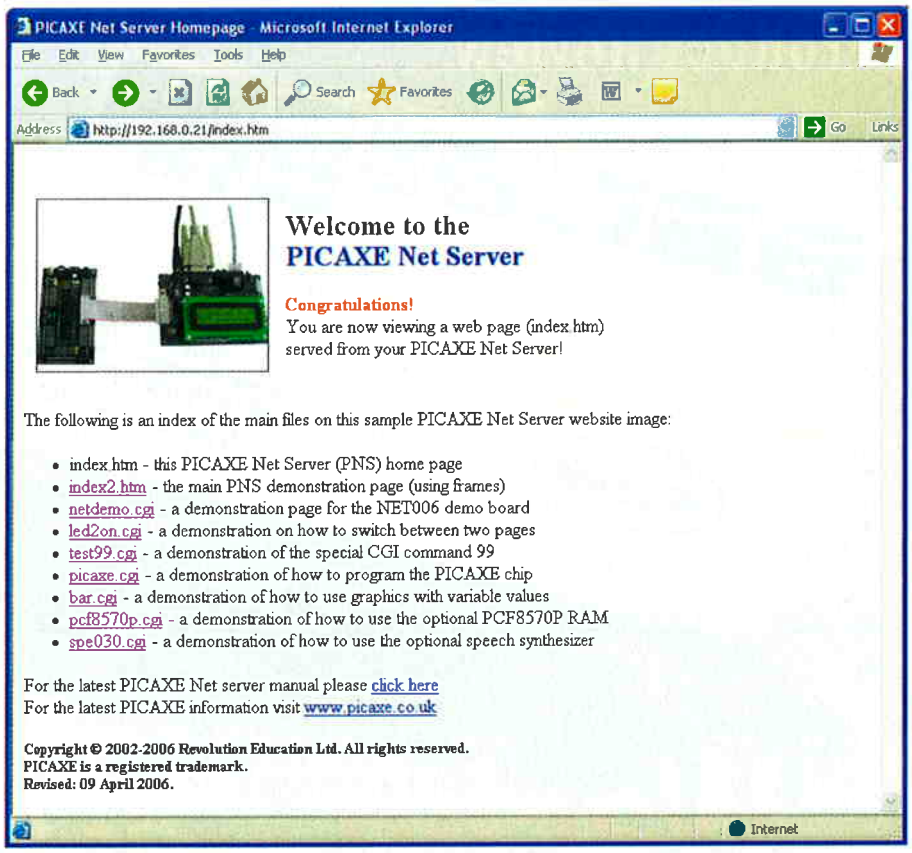
The web page will refresh every three seconds with the PNS input variables. Try holding down the push-button switch on the demo board or heating up the temperature sensor by holding it; you will see the corresponding values change on the page.

Note that because the PNS is a microcontroller-based device, it may occasionally not serve a web page within your browser's timeout period. This will cause a "page not available" error (or similar) to be displayed. In these instances, simply clicking the "refresh" button on your browser should bring up the desired page.

## Mission complete

You have now completed the PICAXE Net Server setup and can access its web pages and perform simple control functions over the network.

Over the coming months, we will describe how to build a more complex PICAXE project and include details on how to make the PNS visible over the Internet. As promised, this will allow you to control your projects over the Internet from anywhere in the world! **SC**


PICAXE Net Server Homepage - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.0.21/index.htm
Go Links
Welcome to the
PICAXE Net Server
Congratulations!
You are now viewing a web page (index.htm)
served from your PICAXE Net Server!
The following is an index of the main files on this sample PICAXE Net Server website image:
index.htm - this PICAXE Net Server (PNS) home page
index2.htm - the main PNS demonstration page (using frames)
netdemo.cgi - a demonstration page for the NET006 demo board
led2on.cgi - a demonstration on how to switch between two pages
test99.cgi - a demonstration of the special CGI command 99
picaxe.cgi - a demonstration of how to program the PICAXE chip
bar.cgi - a demonstration of how to use graphics with variable values
pcf8570p.cgi - a demonstration of how to use the optional PCF8570P RAM
spe030.cgi - a demonstration of how to use the optional speech synthesizer
For the latest PICAXE Net server manual please click here
For the latest PICAXE information visit www.picaxe.co.uk
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Revised: 09 April 2006.
Internet

**Fig.8: once you can access the default page of the PICAXE Net Server, you're ready to test the I/O port. Click on the netdemo.cgi link to get to the tests.**

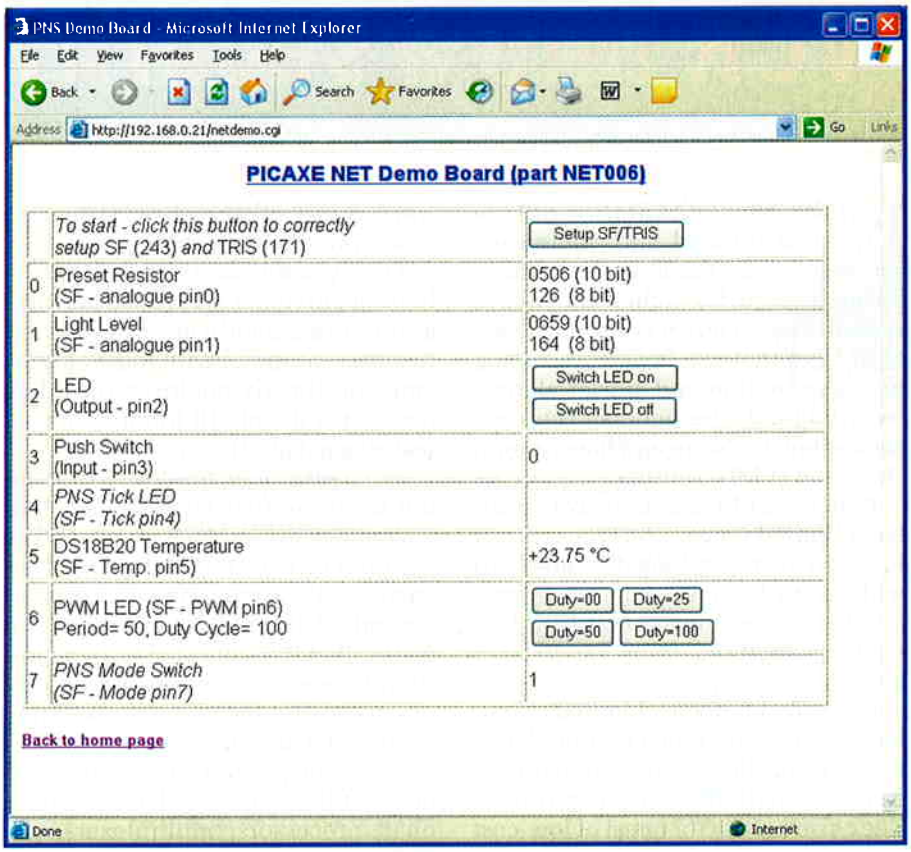

PNS Demo Board - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.0.21/netdemo.cgi
Go Links
PICAXE NET Demo Board (part NET006)
To start - click this button to correctly setup SF (243) and TRIS (171)
Setup SF/TRIS
0 Preset Resistor (SF - analogue pin0) 0506 (10 bit) 126 (8 bit)
1 Light Level (SF - analogue pin1) 0659 (10 bit) 164 (8 bit)
2 LED (Output - pin2) Switch LED on Switch LED off
3 Push Switch (Input - pin3) 0
4 PNS Tick LED (SF - Tick pin4)
5 DS18B20 Temperature (SF - Temp. pin5) +23.75 °C
6 PWM LED (SF - PWM pin6) Period= 50, Duty Cycle= 100 Duty=00 Duty=25 Duty=50 Duty=100
7 PNS Mode Switch (SF - Mode pin7) 1
Back to home page
Done
Internet

**Fig.9: the page allows you to test the PNS input/output port and at the same time demonstrates the remote control capabilities of the system. Click on the "Setup SF/TRIS" button first, then have fun experimenting with the other parameters!**

Product Review

**The "Wachit" Smart Video Motion Detector turns an ordinary VCR/DVD-R into a security event recorder. A built-in learning infrared remote is used to control the recorder. After a simple set-up procedure, all you need to do is hook up the video cable and position the supplied infrared emitter in front of the recorder to begin recording events.**

# "Wachit" – it turns a VCR into a security recorder

By MURRAY DOWNES*

EVERYONE IS FAMILIAR with the passive infrared and microwave sensors that are used to activate door openers, security lights and alarm systems. Less known is the existence of devices that use image processing to detect motion and trigger alarms, recording and other actions. These are generally referred to as Video Motion Detection (VMD) sensors.

Whereas a PIR or microwave sensor has a limited range, VMD sensors can function over very long distances and wide areas because they work from a video camera image that could be viewing anything from 3m to 5km away.

Farco Technologies Limited manufacture high-end video motion detection systems that are used in red light cameras and traffic signal controllers. They also produce a range of low-cost VMD devices that utilise high-speed image processing technology.

The "Wachit" is a small, sturdily-housed unit that's connected between a video camera and a recording device. It comes equipped with relay outputs and can directly control a recording device via its inbuilt infrared remote learning capabilities.

Farco also offer the VMD-19 module for those that wish to use VMD technology in their own products. The module consists of a small printed circuit board with the same footprint as a standard 18-pin 0.6-inch wide IC. It can be directly connected to a composite video source to detect the motion of objects within the video signal. From the outset, Farco designed the VMD-19 for easy integration in security cameras, VCR designs, video switchers, quad processors, multiplexers, etc.

VCR surveillance

When integrated with a VCR, the VMD-19 transforms it into an intelligent motion-detecting surveillance device. When motion is detected within the video signal, the VCR automatically starts recording the scene. Once the motion ceases, the VCR stops recording. This avoids hours of recording of non-eventful static images.

With video motion detection, there is no need for the additional cost

**The VM-19 module consists of a small PC board carrying a single IC and a number of tiny surface-mounted components. The complete assembly is the same size as a standard 18-pin 0.6-inch wide IC.**

*Murray Downes is the Sales & Marketing Manager for Farco Technologies, Ltd.

and complexity of external triggering devices. False alarms that can be triggered by camera noise are largely eliminated in the VMD-19.

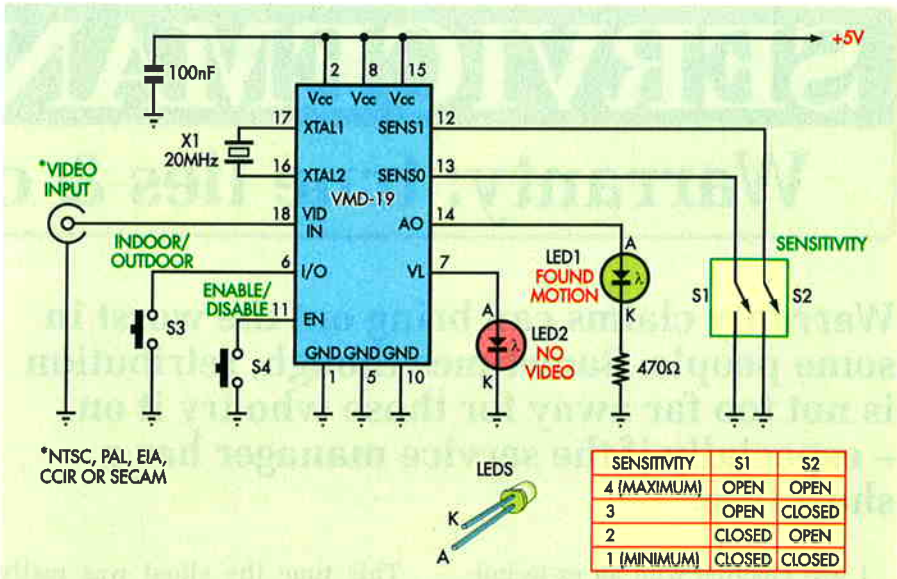
This technology creates an ongoing role for those VCRs that have been made redundant by DVD players. By incorporating Farco's low-cost IC into their circuit designs, electronics enthusiasts now have the means to develop state-of-the-art security/surveillance systems.

The VMD-19 is not just limited to controlling video recorders and can also be put to work in a multitude of trigger and/or indicator applications. Here are just a few possibilities:

- video loss detection
- security light switching
- alarm system enabling/disabling
- gate and door monitoring
- lighting control in storage and utility areas, stairwells, works of art, car parks, freight holding areas, etc.

As well as the obvious home security applications, the VMD-19 has also been used to trigger recording and remote alarms for monitoring wild life (eg, nesting sites).

For more information, contact Murray Downes on +64 3 374 5534 or email sales@farco.co.nz. You can also write to Farco Technologies Ltd, 200 Armagh Street, Christchurch, NZ. Product datasheets and online sales are available from their website at **www.farco.co.nz**. SC




| SENSITIVITY | S1 | S2 |
|---|---|---|
| 4 (MAXIMUM) | OPEN | OPEN |
| 3 | OPEN | CLOSED |
| 2 | CLOSED | OPEN |
| 1 (MINIMUM) | CLOSED | CLOSED |

**Fig.1: this simple circuit demonstrates the capabilities of the VM-19. The composite video signal is fed directly into pin 18. Sensitivity is determined by the logic states of pins 12 & 13, here connected to a 2-way DIP switch. When motion is detected in the video source, pin 14 goes high, illuminating the LED. In an application circuit, this pin would be used to control external recording and/or alarm equipment.**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# SERVICEMAN'S LOG

## Warranty: true lies & confessions

**Warranty claims can bring out the worst in some people. Sometimes though, retribution is not too far away for those who try it on – especially if the service manager has a short fuse.**

I was chatting with an ex-technical liaison officer (TLO) for a major manufacturer the other day who was extremely comfortable with being made redundant. He had had just about enough of whinging clients and the deceit and dishonesty of people trying it on with warranty claims.

In fact, he was fed up with hearing the same outright lies over and over again and could recite some of the pathetic excuses by heart. For example, video cameras are often brought in for repairs under warranty when they have been immersed in the ocean, buried in sand or obviously abused in one way or another.

One classic was a camera with the ability to take still photos which the owner swore blind had hardly been used and had never been abused. When the technician looked at it, he found it was beyond repair because there was sand inside. Confronted with this, the client went ballistic and swore it had been nowhere near any sand whatsoever at any time – not ever. He was absolutely emphatic about this and even accused the company of planting the sand to wriggle out of its obligations.

It is amazing how the more guilty they are, the louder and more obnoxious they often become.

### Items Covered This Month

- Grundig Xentia 82 MFW82-490/9 TV set (Dolby CUC1931 chassis)
- Nakamichi 630 FM Tuner Preamplifier

This time the client was really sprung. The idiot didn't realise he had left the SD (Secure Digital) card inside the camera and that this still worked. The customer's face had to be seen when confronted with the photographs the TLO showed him. They were all close-ups of a 2-year old in a very large sand box, including some with sand actually on the lens.

But it was the picture on his face that was priceless. He took his camera and left, tail between his legs, without so much as a whimper.

Now you may think that the TLO is just there to prevent warranty fraud but that's not all he does. In many cases, of course, the client is given the benefit of the doubt. The TLO is also governed by what is available, the written rules of the warranty and of course, the law. He (or she) is the person who decides whether the item is to be repaired or replaced.

In some cases, it is just not possible to replace an item as it may be completely sold out and there's nothing similar available. However, some customers get very agitated when told that a PC board must be replaced with a refurbished one because new boards are no longer available. Instead, they demand that a new board must be used, even though the refurbished board has been thoroughly tested and is guaranteed.

In stubborn cases, the client is offered the option of having his board repaired at the Service Centre and then sent back and reinstalled. The only problem is that this might take up to six months. Given this option, it's surprising how quickly they change their minds – suddenly, a refurbished board that's available right now is no longer such a bad deal.

Of course, if you are a particularly good whinger, the company may bend the rules and negotiate a deal just to get rid of you. But there's a limit to a TLO's patience as in the case of one over-demanding individual who insisted that his unit be replaced even though it was long out of warranty.

In the end, he was offered a free parts deal with the proviso that he would have to pay for the labour. However, the client continued to aggressively demand a new replacement and eventually went too far. Our TLO, who had had enough, stood up and said that the company was now withdrawing its offer and started to walk out.

Confronted with this, the customer instantly changed his mind and became all sweetness and light. Suddenly the offer was good enough. Our TLO, by now heartily sick of his antics, relented but that guy was dead lucky he wasn't told to "get lost".

### Out of time

On another occasion, a woman brought in an appliance from the country to a repairer in Adelaide, just within the warranty period. The repairer had the unit for six months before telling her he was unable to repair it. It then turned out that they weren't an authorised service centre, so she took it to the correct place but by now it was well out of warranty and the claim was knocked back.

As a result, she got onto our TLO in Sydney and complained but rules are rules – the unit was well out of warranty and it wasn't the company's fault that she had taken it to the wrong place. What's more, the address of the correct service centre was clearly stated on the documentation that came with the unit.

In the end, she reluctantly accepted her fate and the conversation ended.

Afterwards, our hero had a little think about the situation. First, she had been polite and not aggressively

insistent. Second, she had reasonably tried to get the appliance back before the warranty had expired, which isn't so easy if you live 100km out in the bush. The intent was there, so he called her back and said that the company had changed its mind and would cover the repair under warranty.

So you see, there is a heart there – somewhere!

## Tool time

Another bloke I know was the service manager for a trade tool company for several years. And of course, some customers try it on there too.

Now this particular tool company catered mainly to tradesmen and was run by a big red-headed guy with a quick wit and an equally quick turn of phrase. And his service manager was a rather impatient hot-headed type who was not exactly known for tact or to suffer fools gladly.

One bloke came in one day with a hammer drill that wouldn't hammer. The problem was simple enough and the drill was fixed a couple of days later and tested before being returned to the customer.

But that wasn't the end of it. The very next day, he was back with the drill and did he jump up and down. This bloke could really whinge and it's a familiar tune to anyone who works in the service industry . . . the @#$%^& drill still wouldn't hammer, you pay good money to get things fixed and get dudded, you guys are all idiots and couldn't fix a shopping trolley, a bloke wastes his time dropping something in and picking it up and it's still not right, and on and on and on.

Or to use one of the boss's favourite expression, he "carried on like a great big sheila".

"You don't know much about power tools, do you mate?", snapped the service manager, snatching the drill from the customer and plugging it into the nearest power point. "It won't bloody hammer unless you flick this lever to the hammer position" (service manager flicks lever, presses the trigger and the drill goes HAMMER, HAMMER, HAMMER).

"So what the hell is wrong with that, eh?"

"Oh, yeah . . . I musta forgot", says the customer. "Gee, after all that, I feel like a bit of a @#$%head".

"Yeah, you look a bit like one too", said the boss who was hovering in the background, a cheeky big grin on his dial. The customer quickly retrieved his drill and slunk from the shop, the laughter from several nearby tradesmen only adding to his embarrassment.

Poor bloke – it was a month before they saw him again!

He wasn't the boss's only "victim" that month. One guy who had a reputation for being a bit of a know-it-all came in and bought a good-quality electric planer. A few days later he returned to the store for something else and was loudly venting his ill-informed opinions. "You know that electric planer you sold me", he said to the boss. "Biggest @#$%^&* of a tool I've ever owned".

See editorial in this issue for details

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"Nothing wrong with the tool", shot back the boss. "Must be the @#$%^&* using it".

That took the fizz out of him – there was just no comeback to a statement like that.

## Chainsaw Charlie

Another bloke came in with a chainsaw with an engine that refused to start and a chain that had obviously seen much better days. A carburettor overhaul fixed the engine problem and the chain was replaced with a new one and carefully tensioned.

The machine was now running like a bought one and the customer collected it and went on his way to attack who knows what.

Well, you'll never guess what he did attack. A few days later, Chainsaw Charlie turned up at the shop again and wanted the chain replaced under warranty because it had "gone blunt" in such a short time. It was blunt alright – in fact, the chain was utterly stuffed.

But that wasn't all – the engine was covered in what looked suspiciously like cement dust and there were even bits of cement-like material stuck in the teeth of the chain!

When this was pointed out, Chainsaw Charlie freely admitted to using the chainsaw to cut aerated concrete blocks but was still aggressively demanding warranty on the basis of "it oughta be able to handle that!".

"You've gotta be kidding me mate", snarled the service manager. "You must be a complete moron – what sort of idiot uses a chainsaw to cut concrete? Get lost and annoy someone else".

And so Chainsaw Charlie's warranty claim was firmly and tactfully rejected (well, it was tactful for this particular service manager). He picked up his wounded chainsaw and quickly left, never to return.

## Tool in a bucket

This story will be familiar to lots of people in the service industry. It's called the "tool in a bucket" and it's a special collection of bits that's created by blokes who overestimate their mechanical abilities.

Actually, those bits start off all joined together as one tool. But then, that tool fails for whatever reason (often through abuse) and so Bob or Mal or George (or whatever his name is) decides to dismantle it to find out what's wrong. After all, he can fix anything, can't he?

The trouble is, many professional power tools are quite complicated beasts inside, with more bits and pieces than you can poke a stick it. So even if he spots the problem (unlikely), Bob then can't figure out how it all goes back together again.

And so it all goes into a plastic bucket to keep everything together and that's how it's brought in.

The big red-headed boss loved it – it was time for a bit of fun at someone else's expense. "Ahaaa . . . another tool in a bucket. We get lots of these", he would loudly exclaim so that everyone in the shop could hear whenever one was brought in. "Are you sure you've got all the bits in there mate? You haven't lost any springs have you?".

The customers' reaction to this leg-pulling varied. Some would quite readily admit that they didn't have a clue how to put all the bits back together again. Others would sheepishly admit that they'd bitten off more than they could chew while still others would try to weasel out with: "yeah, well I've pulled it down for you but I don't have the time to put it back together. So I thought I'd get you to finish the job".

Yeah, right.

For those of you who have never seen a "tool in a bucket", it's important to note that there are quite a few models in the range. They include the "tool in a shoe box", the "tool in an Esky", the "tool in a green garbage bag", the "tool in an old pillowcase", the "tool wrapped up in newspaper" and lots of other variations. But regardless of the container, they all begin life in much the same way.

Invariably, too, there will be bits missing. As the service manager put it, you had to lay all the bits out on the bench and go through it all bit by bit – just like an air-crash investigation!

## Dragging the chain

I've saved the best until last.

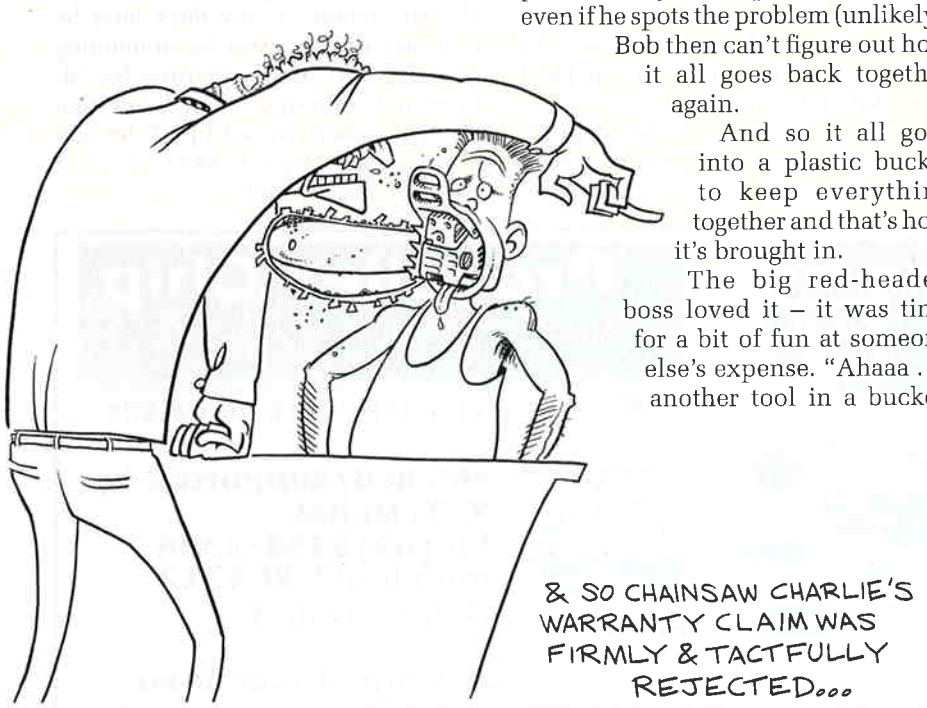
A blue heeler dog came into the tool shop early one morning, accompanied by two young builders who knew exactly what they wanted. They forked out the best part of $800 for a 2.5kVA petrol-driven alternator and were last seen driving from the carpark in their old diesel truck, the alternator box in the back and the dog perched up on the seat between them.

A week later, the dog brought the two blokes back in and they wanted another identical generator. "I sold you one of these last week", observed the service manager. "How come you want another one?"

"Yeah, well the first one failed, didn't it", came the matter of fact reply. "So we want a new one".

"Why buy a new one?", quizzed the service manager. "It's under warranty; bring it in and we'll fix it free of charge."

"Not this time mate", one of the young blokes shot back. "You wouldn't



cover this one with warranty".

"I think I'd like to hear about this", said the service manager.

Well, it wasn't all that complicated. The two young blokes had finished work for the afternoon and had loaded the generator onto the back of the truck where it was secured by a chain. And they and the dog were driving home with the stereo cranked up when motorists coming the other way started flashing their headlights at them.

After about 3km of this, they decided they'd better stop and see if anything was wrong with their truck. The first thing they saw when they went round the back was an open tailgate. The second thing they saw was the mutilated remains of their new generator lying on the road. It was still attached to the chain, the other end of which was still attached to the truck!

@#$%er. They'd just dragged their new $800 generator 3km along the highway. You can just picture it can't you – the old diesel truck, the music, the dog in the front, and the shower of sparks against the setting sun. It must have been quite a sight – no wonder other motorists flashed their lights in appreciation.

As one of the young blokes put it: "mate, it was well and truly stuffed. There were bits of generator everywhere. So we thought we'd buy a new one and not worry about warranty".

They weren't the slightest bit embarrassed about the mishap either.

It was just one of those things that happens.

Has anyone else got any interesting warranty stories?

## A tricky Grundig

Now back to some regular servicing stories. Having had difficulty troubleshooting a couple of later Grundig models, I am now rather wary of taking them on. My problems stem largely from the fact that I'm no longer a Grundig service agent and so not factory trained by them to service their sets.

However, I also need money and so I recently reluctantly took on a Grundig Xentia 82 MFW82-490/9 Dolby TV set using a CUC1931 chassis. Apart from the red LED, this set was otherwise dead.

With the set up on the bench, the next challenge was getting the chassis into a position where I could access the PC board. That's not quite as easy as it sounds, as the set becomes a little unstable when the back is removed and the shortness of the wiring harness doesn't make things any easier.

The first thing that struck me was that there were quite a few dry solder joints, especially around the flyback transformer. And in line with other European sets, the components positions are not marked on the solder side, making a complex set like this even harder to repair.

Unfortunately, the fault was still there after a major rework of the soldering and it didn't take a mental giant to work out that the line output transistor (T53001, 2SC5331) was short circuit. Further investigation then revealed that R55014 (4.7Ω) to the east-west IC (IC55010, TDA8145) and R53008 (10kΩ) across D53008 had burnt out. The former was understandable but the latter was inexplicable.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These parts are hard to access so replacing them wasn't all that easy. And it didn't help matters when the transistor heatsink clamp fractured and broke.

You would have thought that after resoldering the dry joints and replacing the transistor, IC and resistors that all might be well. However, this set was in full blitzkrieg mode and fighting me all the way. At switch-on, the transistor failed instantly and the EW resistor started burning again.

As a result, I next removed and checked about a dozen capacitors in the line output deflection stage. C3006 and C3007 – both 0.25µF 250V polyesters – were open circuit and I changed C53009 and C53012 for good measure as well. You can imagine my frustration when I subsequently switched the set on again and nothing happened.

It took me quite some time to find the real cause of the problem but by then, my stiff upper lip had well and truly failed. In short, Murphy's Law had struck again.

Murphy's Law comes in a couple of variations, one of which is "whatever can go wrong, will go wrong". Another variation is "if there is a wrong way to possibly do something, someone will do it". Well, I did it.

Like lots of other manufacturers, Grundig decided to use crimped plugs without any markings on them. And despite the shortness of some leads, some of them will easily reach more than one identical socket. In this instance, a 3-pin lead and plug from ST-GM2 on the CRT board can comfortably reach a 3-pin socket on top of the deflection yoke correction board which is not shown anywhere in the service manual.

Unfortunately, it also fits a concealed socket on the righthand side of a coil on the neck of the tube, which is actually the correct one. This plug had to be removed to get the chassis in and out of the cabinet.

Anyway, I had plugged it into the wrong socket, causing the set to go dead. And in the course of all this work, I had also managed to kill the sound by carelessly breaking L40111, a 10µH coil which feeds +5V to IC40110 on the lefthand AF module.

I must admit I wasn't a happy traveller.

## The humming Nakamichi

Recently, we had a Nakamichi 630 FM Tuner Preamplifier brought into us with a number of problems, the first being a humming noise. The owner had had a variety of technicians look at this and by the time he brought it to us, it had developed two more symptoms. In addition to the hum, there was a loud bang in the loudspeakers when it was first switched on and then the volume would jump up to high and the sound would intermittently distort.

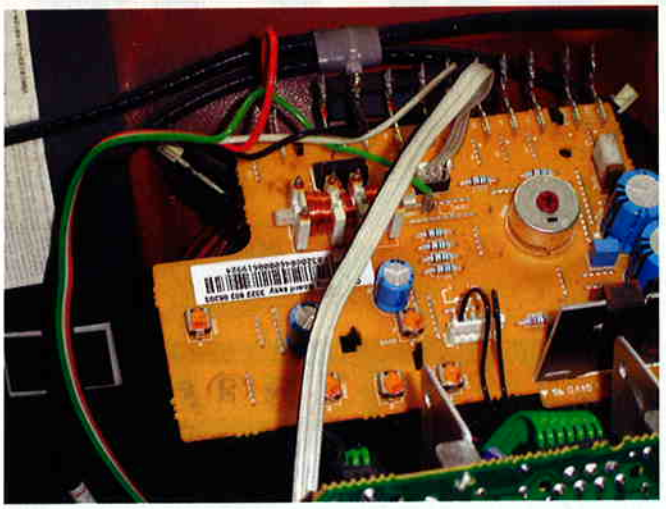
Our audio technician tackled the latter faults first and soon worked out that the power-on muting circuit wasn't working properly and was pulling the negative part of the signal to ground. This circuit is in the power supply and is designed to slowly release the mute circuit to avoid loud noises at switch-on.

In practice, this is done by a applying a positive voltage to the base of PNP transistor Q911, thereby switching it off and allowing C906 (22µF) in the collector circuit to charge from a -10V rail. When this voltage exceeds the base-emitter voltage of Q910 (PNP) the latter turns on, in turn switching Q909 on and releasing the mute. The time constant is determined by R914 (1MΩ) and C906.

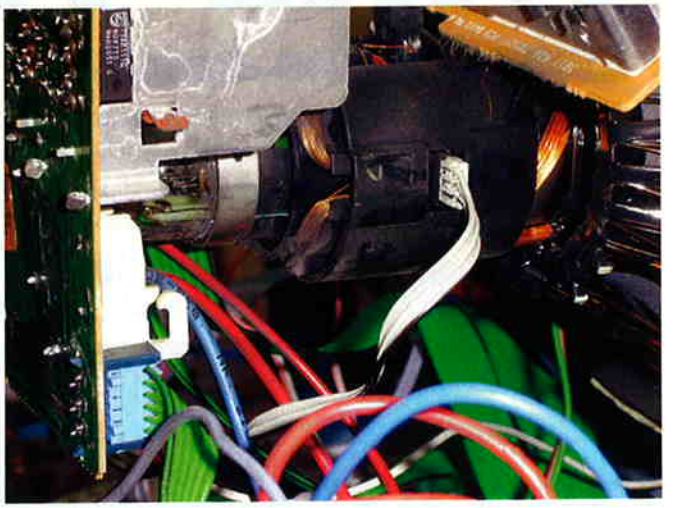
Our technician soon discovered that someone had replaced Q909 (2SA945) and Q910 (2SA733) and had inadvertently swapped the transistors around. So that fixed the muting problem – all he had to do now was fix the hum.

His approach was to monitor various sections of the circuit with a CRO while listening to the amplifier through headphones. It took a while but he eventually isolated the fault to the power supply when he moved the ground point for the CRO probe to the BLK GND fuseholder. By slightly moving the cartridge fuse in the holder, he found that he could make the hum come and go.

Fairly obviously, there was a certain amount of resistance between the holder and the fuse which was causing the problem. Cleaning both and reforming and crimping the holder so that it held the fuse more firmly finally fixed the hum. **SC**



**Murphy's Law in action – plugging the Grundig's 3-way lead from the CRT board into a matching socket on the deflection yoke correction board caused the set to go dead.**



**This photo show the correct location for the 3-pin plug which goes into a socket on the righthand side of a coil on the neck of the tube.**

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# PRODUCT SHOWCASE

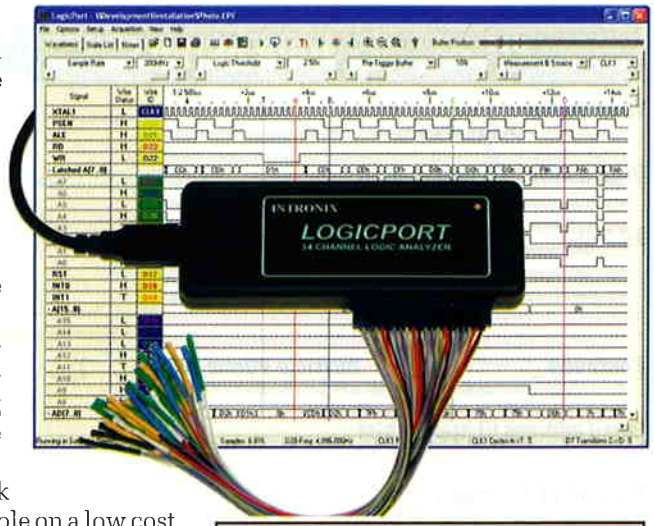
## Intronix LogicPort USB Logic Analyser

This compact, USB-powered analyser packs in many features previously only found in professional units costing many times more. While most PC-based Logic Analysers boast 8 or 16 channels, the LogicPort has 34 – enough to monitor a full 8 bit data bus, 16 bits of address and various control signals simultaneously.

It is no slouch on the speed front either – 500 Mega Samples per Second (MS/S - 500MHz) sampling on internal clock and 200MS/S in state mode (external or bus clock).

It has sophisticated multi level triggering that makes it possible to capture just the right block of data, thus avoiding the need to scroll through thousands of samples looking for the right events. Commonly, simple analysers allow you to trigger when a certain bit pattern occurs on selected inputs. The LogicPort allows you to trigger on simple or complex patterns of levels or edges, a range of values on a defined group of inputs, pulse minimum or maximum durations or pulse counts.

It also has hardware data compression, so that if nothing is changing on the data, no buffer space is wasted recording blank samples. Also remarkable on a low cost instrument are the serial protocol interpreters, which allow you to capture serial data (RS232, RS484, I2C, SPI and more) and have the serial data decoded and actual data bytes displayed.

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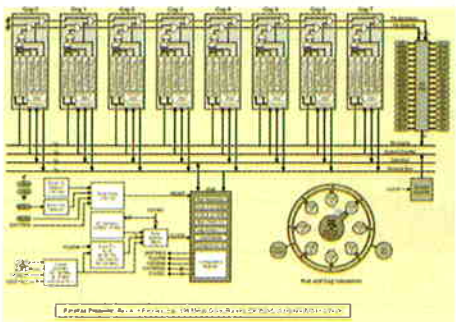
## Parallax 'Propeller': eight 32-bit processors (COGs) in one chip!

Parallax, previously mainly known as manufacturer of the so-called Basic Stamp, has developed its own microcontroller, called the "Propeller". It is based on a completely symmetrical arrangement of eight RISC processors (so-called "Cogs") that work completely autonomously, processing controller tasks either individually or in co-operative groups.

Each Cog is clocked at up to 80MHz delivering a maximum of 20 RISC MIPS (4 cycles per instruction). In addition, the clock management system allows for standby operation at less than 10µA at 3.3V supplies.



Besides 32Kbyte global RAM and 32Kbyte ROM containing character sets, sine wave and log/antilog tables, each Cog owns 2Kbytes local RAM, which can be used in different ways depending on the software concept. For object-oriented programming, Parallax has developed an easy-to-learn programming language called "Spin" which is syntactically similar to the common programming languages. Compiled Spin code stored in the global RAM is executed by an extremely fast interpreter, which is loaded into the local RAM of each Cog. Alternatively, individual Cogs can also execute Assembler code in order to achieve maximum computing performance. Of course, the Propeller Assembler is unique to this platform but has obvious similarities with Z80 Assembler and is therefore easy to learn.

In the Propeller chip, there is no prioritisation among the Cogs. Each Cog can carry out tasks individually, initialise and start or stop any other Cog. Access to the common data pool (global memory) is made in a time division fashion.

Each Cog can generate either VGA or composite video.

Many of the high level functions that exist for the Basic Stamp modules have already been developed. The editor program can be downloaded from www.parallax.com

With the Propeller chip, Parallax did not invent parallel processing, which has been around for a long time (eg Transputers). However, with the Propeller chip parallel processing is now available in the form of a single device competing with ARM7 and other microcontrollers, delivering enormous computing power combined with a lot of flexibility.

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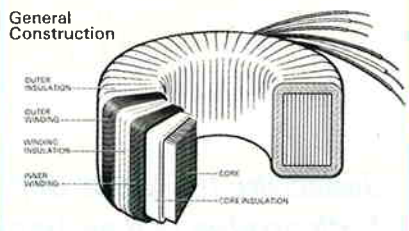


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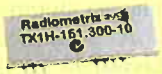


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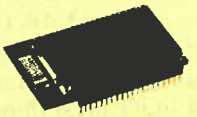

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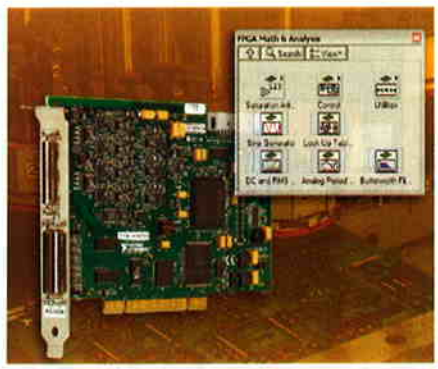
## NI LabVIEW 20th Anniversary edition



2006 marks the 30th anniversary of National Instruments and the 20th anniversary of LabVIEW.

During the past two decades, LabVIEW has evolved from a desktop instrument control and data acquisition tool to an integrated design, control and test platform for desktop, industrial, embedded and handheld applications.

With a flexible, open platform, LabVIEW continues to deliver productivity to engineers and scientists facing increasingly complex application needs.

The company has released a 20th Anniversary edition of LabVIEW, delivering general compatibility with The MathWorks, Inc. 'MATLAB' Software, FPGA-based rapid system prototyping and new modulation toolkit

LabVIEW 8.20 enhances the industrial measurement capabilities of LabVIEW with new features designed for advanced analysis and control, improved distributed system management and new targets for human-machine interfaces (HMIs).

For instance, new libraries in LabVIEW allow engineers to use streamlined FPGA targeting tools to implement high performance, hardware-based machine monitoring and protection systems and the new LabVIEW Touch Panel Module, which helps them to use the same software to create Windows CE-based HMIs.

LabVIEW 8.20 engineers and machine builders can use one software tool to design and deploy industrial systems performing high-performance measurements, FPGA-based advanced analysis and control, communication to existing systems and human-machine interfacing.

Contact:
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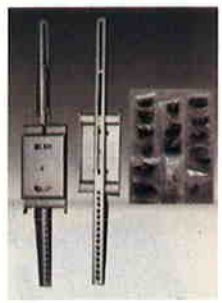
## Aussie Plasma mount



Plasma mounts are notorious for being bulky, unattractive and expensive. Australian Company, Skunkworks, has won a lot of fans with its affordable range of plasma mounts.

A particular favourite of installers is the flat-to-the-wall Vasco range, which has now become even better with a low-cost version, the Vasco 946.

This allows a large LCD or plasma panel to be mounted neatly and flat to the wall. It features a universal split-fitting which suits almost any kind of large flat screen, with no additional adaptor plates required. The design is such that the system can be used on uneven surfaces such as brick and stone. Two hinged brackets fit securely on the wall allowing the screen to sit flat.

The solid steel unit is finished in a powder-coated silver sheen and comes complete with a 108-piece installation kit, which includes fixing hardware for all size screens and installations.

The Vasco 946 has a 50kg weight loading. However, it's the cost saving that's the big difference. With a retail price of $159, it is nearly $50 cheaper than the Vasco 945 and a third of the price of many competitors.

Contact:
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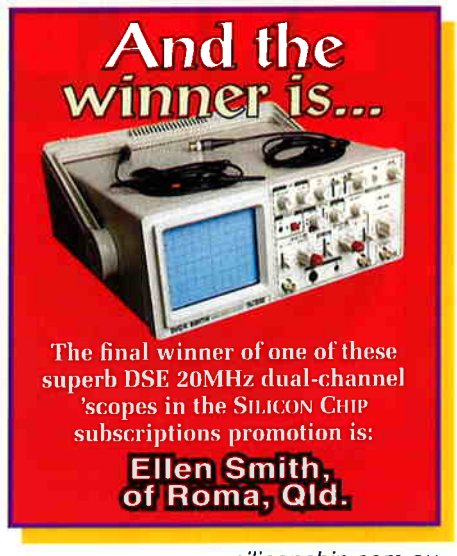
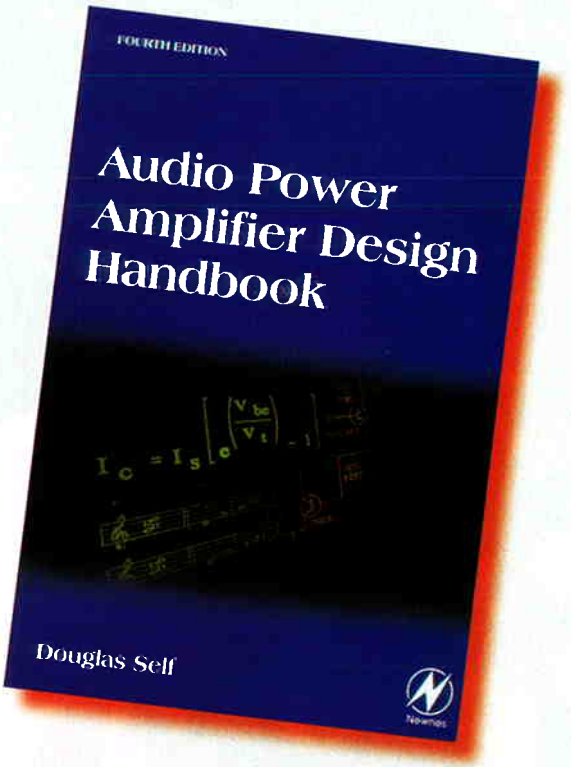

And the winner is...
The final winner of one of these superb DSE 20MHz dual-channel 'scopes in the Silicon Chip subscriptions promotion is:
Ellen Smith, of Roma, Qld.

# BOOK REVIEW

## An audio myth-busters bible

**Audio Power Amplifier Design Handbook**, by Douglas Self, 4th Edition published 2006 by Elsevier. Soft covers, 156 x 233mm, 465 pages. ISBN 0 7506 8072 5. RRP $83.90




This is a great book. I spent the best part of a weekend reading it and thoroughly enjoyed it. I have read previous editions and it was a pleasure to revise so much fundamental audio amplifier design theory and practice. Based originally on a series of articles in *Electronics World* magazine, the text has been substantially added to and revised by Douglas Self in the later editions.

Many of the design principles described by Douglas Self have been employed in our own SILICON CHIP designs, notably the 15W class-A design from the July & August 1998 issues and the Ultra-LD 100W design from March, May & August 2000 and revised in November, December 2001 and January and July 2002. Having read through the 4th edition and with the availability of some new transistors from On Semiconductor (previously Motorola), we now think we can do even better.

If you already have the 3rd edition, the new material in this book centres mainly on two chapters, one on the Design of DC Servos (to minimise DC output offsets) and another on class-D Amplifiers. Ultimately, he is pretty dismissive of class-D as far as low distortion is concerned.

There is a total of 17 chapters in the book. The first chapter sets the scene, as a general survey of audio amplifiers, including the paradox that when it comes to high cost amplifiers, those that are really expensive often have the highest distortion, which is mainly because of the success of the promoters of subjectivist ideas such as all "negative feedback is bad". Indeed, anyone who is truly interested in learning about audio amplifiers could save themselves from being deluded by buying and reading this book; they can also save a great deal of money by not buying equipment which is designed to meet the subjectivist market!

Chapter 2 is devoted to amplifier architecture and negative feedback. It discusses all the various amplifier classes, from class A to G and is a very good treatise on negative feedback. Chapter 3 is on general principles of power amplifiers and introduces Douglas Self's concept of the eight distortions which go to make up the total harmonic distortion performance of an amplifier. Much of the rest of the book is devoted to eliminating those distortions to produce the "blameless amplifier".

Chapter 4 covers the small signal stages which are the differential input stages and the crucial class-A voltage amplifier stage. Chapters 5 & 6 are on the output stage and are mainly devoted to complementary emitter follower stages and the complementary feedback pair.

Chapter 7 is devoted to frequency compensation, slew rate and stability while, chapter 8 is devoted to power supplies and power supply rejection ratio (PSRR).

Chapter 9 is on class-A power amplifiers and introduces Douglas Self's trimodal amplifier which operates in class-A or class AB, depending on load conditions. Chapter 10 discusses class-G amplifiers. These switch their supply rails high or low, depending on input signal levels. Chapter 11 is on class-D amplifiers (already mentioned) while chapter 12 is on FET output stages. Here, Self comes down very much in favour of bipolar transistors because of -their better linearity, lesser gain spread and far less likelihood of instability. (This has always been the SILICON CHIP line).

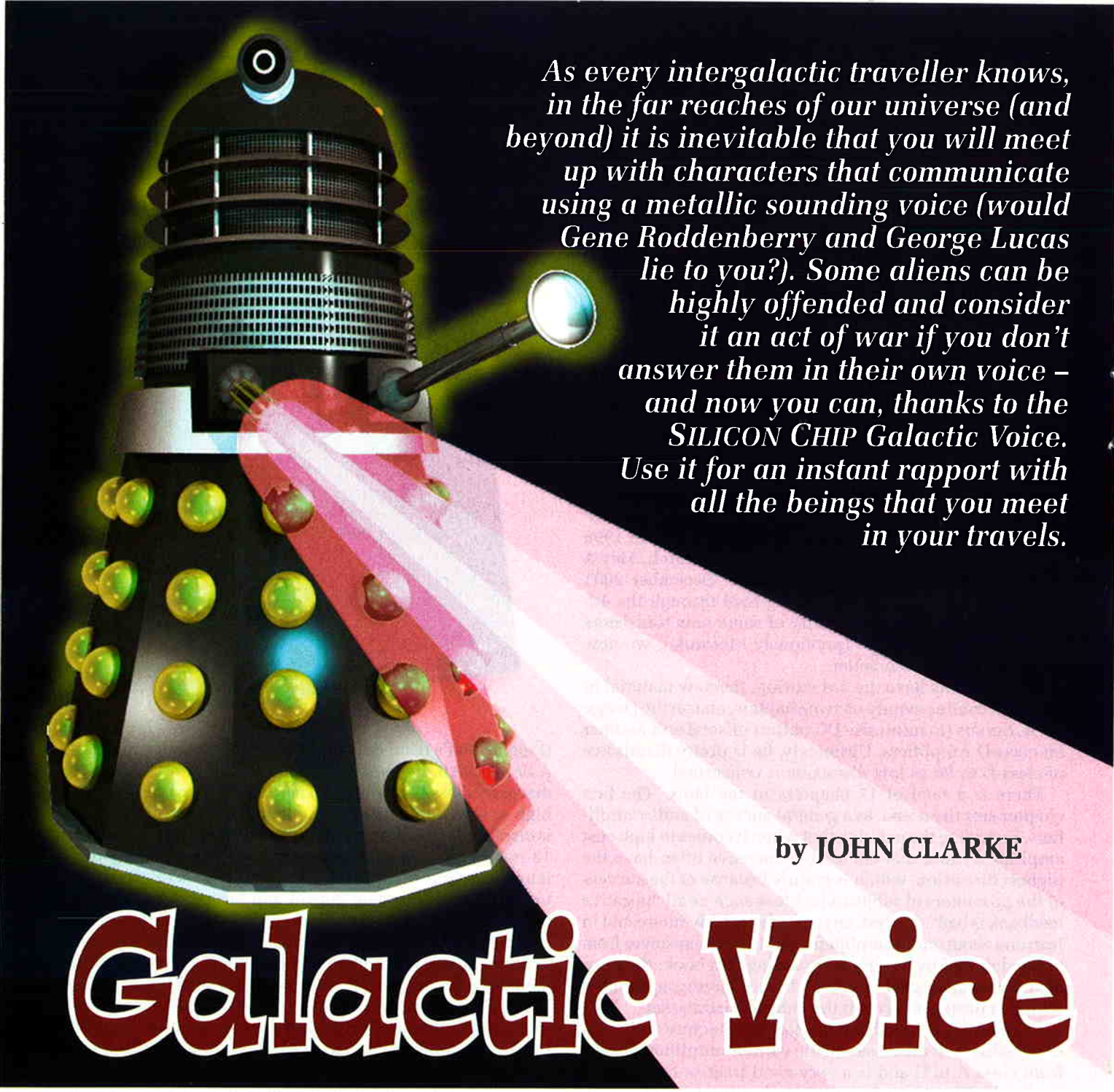
Chapter 13 is devoted to thermal compensation and thermal dynamics, while chapter 14 is on DC servos (already mentioned). Chapter 15 is on amplifier and loudspeaker protection and comes down in favour of relay switching over other schemes involving fuses or crow-bar circuits. Load-line protection is discussed in detail, with both single slope and dual circuits being outlined.

Chapter 16 is on grounding and aspects of PC board design and finally, chapter 17 is on testing and safety.

The book is heavily illustrated with distortion plots produced on Audio Precision equipment (the same as used by SILICON CHIP) and there are extensive bibliographies at the ends of most chapters.

Clearly, this is one of the best books ever written on audio amplifier design, if not the best. It blows away a great deal of amplifier design mythology and is highly recommended for anyone who wants a deeper understanding of amplifier design, whether they are a designer or just a listener. (L.D.S.) **SC**

**This book is available from the SILICON CHIP Bookshop – see pages 108-109 of this issue for more information.**



*As every intergalactic traveller knows, in the far reaches of our universe (and beyond) it is inevitable that you will meet up with characters that communicate using a metallic sounding voice (would Gene Roddenberry and George Lucas lie to you?). Some aliens can be highly offended and consider it an act of war if you don't answer them in their own voice – and now you can, thanks to the SILICON CHIP Galactic Voice. Use it for an instant rapport with all the beings that you meet in your travels.*

by JOHN CLARKE

# Galactic Voice

**We've all seen and heard** those sci-fi TV programs and films which include characters – either real "living" beings or fully robotic 'droids – that speak with electronic sounding voices.

The living beings are often heavily modified with mechanical and electronic prosthetic devices. The modifications extend to voice changing headpieces designed to cause menacing expressions.

The voice changing tends to bring out the worst evil features from the characters. Some examples of characters from the galaxy with metallically challenged voices (and with bad attitudes!) include the Droids from "Star Wars", the Cylons from "Battle Star Galactica" and the Daleks from "Dr Who".

Who could not resist holding their arm out and saying "Exterminate, Exterminate, we are the Daleks" especially when armed with a metallic-sounding voice?

Each of these characters has their own distinctive voice signature and the SILICON CHIP Galactic Voice includes controls to match the required character.

Imitating the voices is as simple as switching on the Galactic Voice and speaking in a normal voice into an inbuilt microphone. The electronics and the loudspeaker do the rest for you, converting your normal, totally boring voice into a metallically accented diabolical one.

**Just add your voice and you too can sound like a Klingon, Dalek, a Droid, a Cylon . . . you name it!**

There is an "effect" control which changes the metallic effect by changing the pitch of the metallic sound from a high through to a low pitch.

There is also a "depth" control, which adjusts the amount that the metallic sound is impressed upon your voice, from a relatively normal voice through to a fully metallic voice.

A volume control sets up just how much sound you can deliver to your fearful audience. The maximum overall volume is similar to that produced by your own voice when speaking normally. Too much volume will cause feedback between the microphone and loudspeaker and produce a loud squeal.

## How it looks

The Galactic Voice unit comprises a 120mm long, flared plastic tube with a loudspeaker mounted inside the flared end. The controls are located at the opposite end of the tube. This end is held close to the mouth so that you can speak directly into the microphone.

A power switch is used to switch the Galactic Voice on or off and a LED indicates when power is on.

## How it works

Fig.1 shows the block diagram for the Galactic Voice. Signal from the microphone is amplified by IC1 and sent to a mixer, IC3. This combines the amplified signal with a square wave carrier signal produced by variable frequency oscillator IC2.

The frequency of oscillation is set by the "Effect" control, while the "Depth" control sets the amount of signal that is applied to the mixer.

Output from the mixer is the carrier signal produced by the oscillator but with the level of this signal following the shape of the amplified microphone waveform.

As could be expected this significantly changes the way the signal sounds – the sound produced is similar to the metallic sounding voices we know so well.

The resulting metallic voice sound is applied to the power amplifier (IC4) via the volume control (VR3).

The waveforms overleaf show the results of the modulation where the oscillator signal is mixed with the amplified audio signal from the microphone.

The waveform at top is the amplified signal from the microphone, while the lower waveform is the signal after the mixing. The signal shown is taken from the power amplifier output. You can see that this signal is the oscillator waveform modulated in level according to the microphone signal.

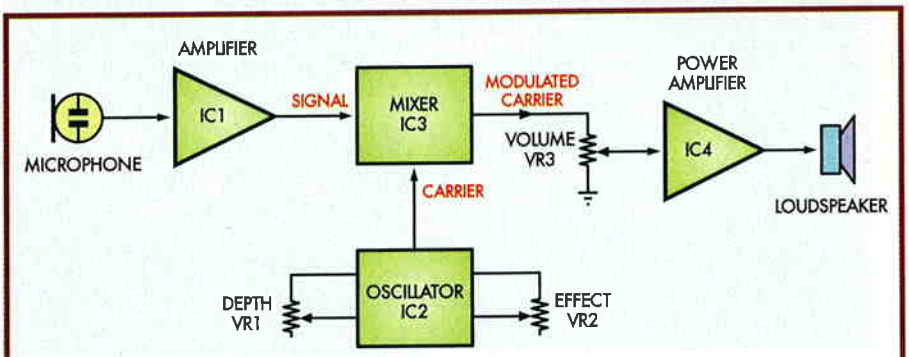



**Fig.1: the block diagram of the SILICON CHIP Galactic Voice. Compare the functional blocks with the circuit diagram overleaf.**

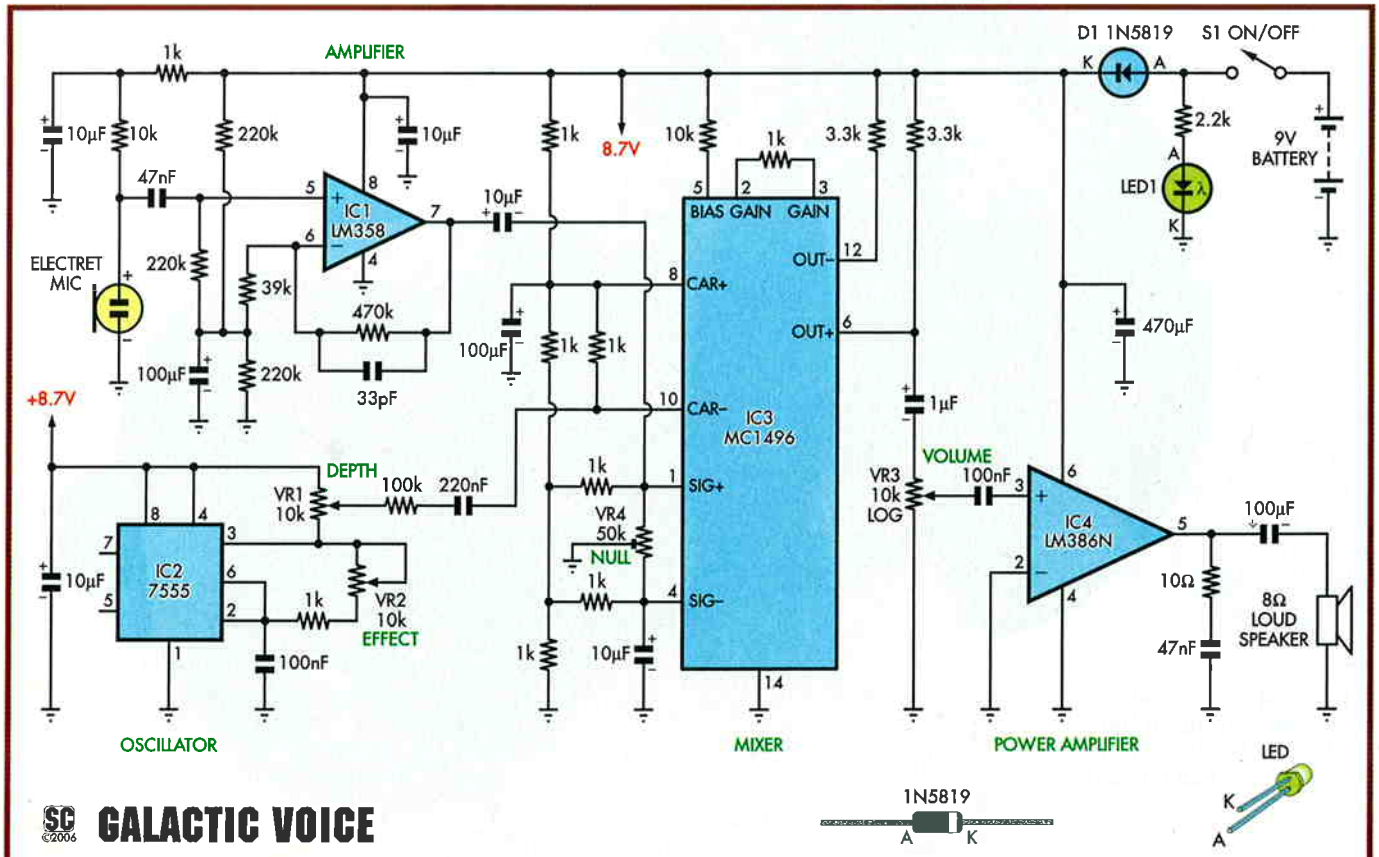



**Fig.2: the microphone singal is amplified by IC1, then mixed with a variable square wave from IC2 to produce a modulated square wave, as shown below. IC4 further amplifies the signal to drive a small loudspeaker.**

## The circuit

The circuit has just four low-cost ICs, two other semiconductors, three potentiometers, a microphone, a loudspeaker and a few other components.

We'll start with the electret microphone. These types of microphones require a power supply; in our case it is derived from the main supply rail via a 1kΩ decoupling resistor and a 10kΩ limiting resistor.

This supply is filtered with a 100µF capacitor to minimise any voltage fluctuations on the main supply (which would happen as the amplifier works hard) from being passed into the sensitive microphone circuitry.

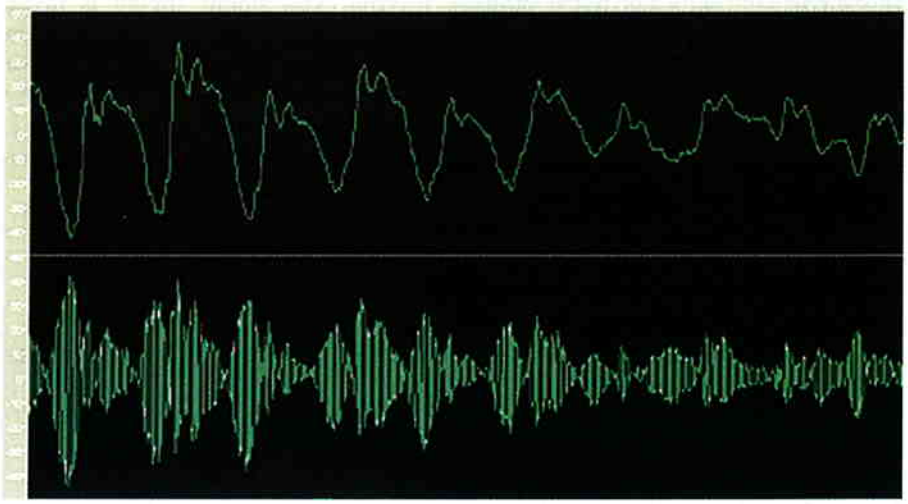
Signal from the microphone is AC-coupled to the non-inverting input of amplifier IC1a, half of an LM358 (the other half is not used). It has a gain of about 13, set by the 470kΩ resistor between pins 7 and 6 and the 39kΩ resistor at pin 6. The 33pF capacitor rolls off the amplification above 10kHz to prevent possible oscillation in the amplifier.

IC1a is biased at close to half the power supply voltage via two 220kΩ resistors connected as a voltage divider across the nominal 8.7V supply. (We'll explain why it is 8.7V shortly).

The resulting 4.35V nominal supply is filtered with a 100µF capacitor. The idea of biasing IC1a at this nominal 4.35V is so that the output is able to swing symmetrically above and below this voltage.

Before we look at where the output goes, let's turn our attention to the carrier oscillator, IC2. This IC is a CMOS version of the famous 555 timer and is used because it draws far less current than the standard version.

The timer is connected to produce a continuous square wave signal and operates as follows: Pins 2 and 6 are the threshold inputs that monitor the 100nF capacitor voltage. This capacitor is charged and discharged via the



**The top waveform is the voice signal, amplified after being received by the microphone. The bottom waveform is at the audio amplifier and shows the carrier signal modulated by the to p waveform**

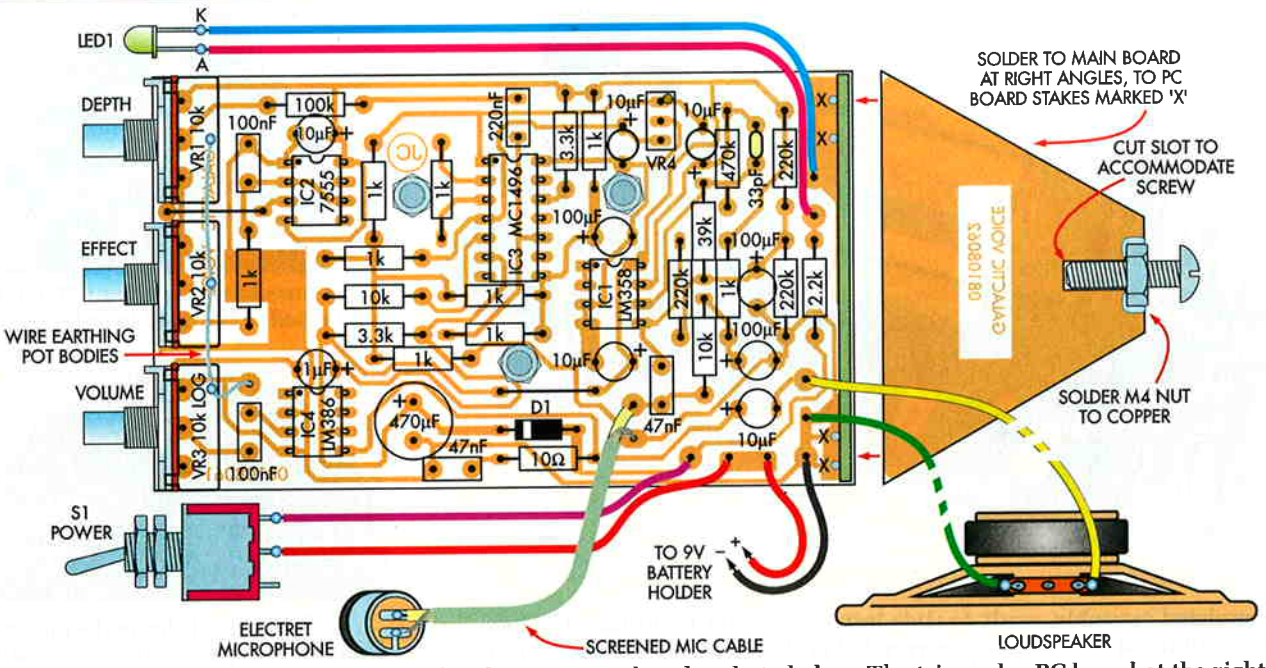



**Fig.3: here's how to put it all together – this diagram matches the photo below. The triangular PC board at the right end mounts vertically onto the four PC pins. This board needs a little "surgery" first to fit the nut and screw.**

variable resistance VR2 and the 1kΩ resistor, via the output at pin 3. When charging, pin 3 is high (at the supply voltage) and the capacitor voltage rises. When the voltage reaches 2/3 the supply voltage (detected by the input at pin 6), pin 3 goes low (at 0V).

The 100nF capacitor now discharges until the voltage reaches 1/3 the supply voltage (detected at pin 2). Pin 3 goes high again to recharge the capacitor. The process continues and a square wave is produced at pin 3. The frequency can be set from 655Hz and 7.2kHz by varying VR2.

Potentiometer VR1, connected between the pin 3 output of IC2 and the 8.7V supply rail, provides control over the carrier level.

With the wiper of VR1 wound fully toward the 8.7V end, there will be no output signal. As VR1 is wound down, increasing amount of square wave from pin 3 will pass through, with full signal available when the wiper is turned fully toward the pin 3 end of the potentiometer.

VR1 therefore provides a depth control of the modulation. The 100kΩ resistor in series with the wiper limits the modulating level to a maximum of around 50mV, thus preventing overload at the maximum setting of VR1.

## Into the mixer

The output of IC1, taken from pin 7, is AC-coupled to the signal + input of the mixer (IC3) at pin 1. The signal – input (pin 4) is coupled to ground via a 10µF capacitor. Because of this, signal is only applied to the signal + input.

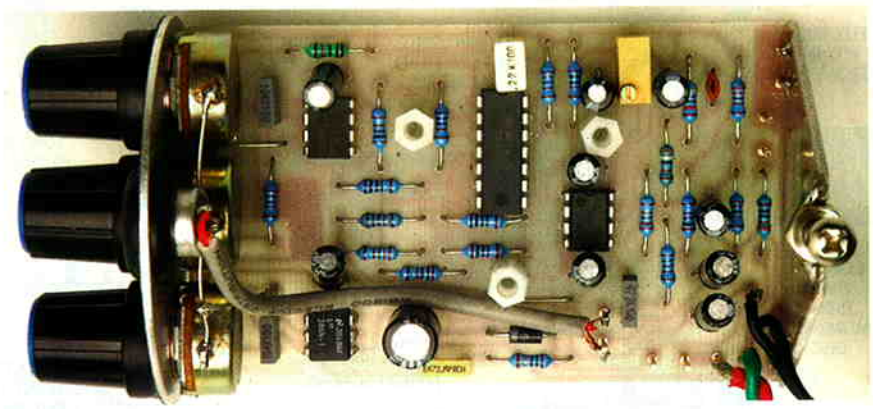
At the same time, the output from IC2, taken from pin 3 via the depth control, is AC-copuled to the CAR- input (pin 10), with the CAR+ input (pin 8) also AC-coupled to ground.

There are three 1kΩ resistors forming a resistive divider between the 8.7V supply rail and ground. Pins 1 and 4 of IC3 connect (via 1kΩ resistors) to the lower resistor in this divider. VR4 allows the circuit to be balanced. Balancing removes the carrier signal from the mixer output when there is no applied signal at the signal + input.

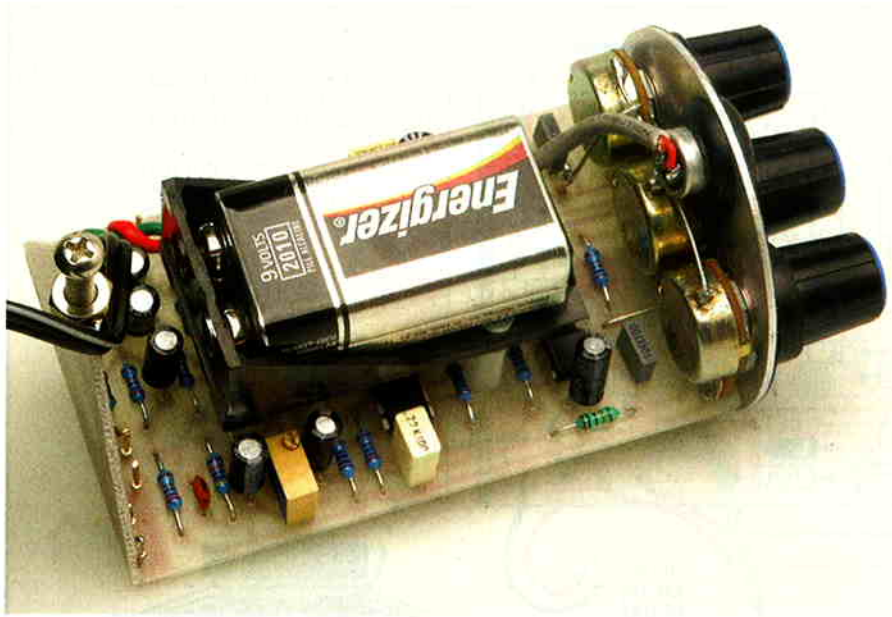
The carrier signal is applied to the pin 10 input, which is biased to the top 1kΩ resistor in the divider string and the voltage is decoupled with a 100µF capacitor. The carrier + input is also fixed at this bias voltage.

The mixer outputs (pins 6 and 12) are biased with 3.3kΩ resistors to the 8.7V supply. The 10kΩ resistor from pin 5 of IC3 sets the overall bias of the mixer and the 1kΩ resistor between pins 2 and 3 set the mixer gain.

Output from the mixer (pin 6) is coupled via a 1µF capacitor to the



**This photo, reproduced close to life size, shows the populated PC board before the battery holder is screwed onto the three standoffs (the white hexagonal pillars). The M4 screw (right end) would normally not be inserted until after the assembly is placed inside its plastic tube "case" – we left it there 'cause we didn't want to lose the screw!**




The completed assembly, ready to slide into the speaker port tube. The two apparently unused PC stakes at the very left of the board are for the control panel LED and are actually soldered to underneath the PC board.

This shows how the support PC board is attached to the main board. . .

. . . while this shot shows the underside of the control panel with power switch and LED.

volume control, VR3. This adjusts the level of signal applied to the power amplifier, IC4.

The amplifier drives the 8Ω loudspeaker, via a 100µF capacitor which blocks the DC component from IC3's output. The 10Ω and 47nF capacitor at IC4's output provides a substantially capacitive load at higher frequencies to prevent the amplifier from oscillating.

## Protection

The circuit is powered by a 9V battery, controlled by power switch, S1. As you no doubt realise, it is far too easy to reverse-connect a 9V battery, which can – and often does – let the smoke out of semiconductors. So diode D1 prevents current flow if the battery is connected the wrong way around.

The diode deserves special mention: it is a Schottky type, not a normal silicon variety. Schottky diodes have a voltage drop about half that of silicon diodes (0.3V vs 0.6V), thereby maximising battery life.

The main supply is therefore a nominal 8.7V, due to the 0.3V voltage drop across D1. LED1 is included to indicate whenever power is on.

Overall current drain is less than 14mA with a 9V battery, which should give about 300 hours of battery life with a fresh alkaline battery and intermittent use.

## Construction

Most components for the Galactic Voice are assembled onto a 93 x 55mm PC board, coded 08109061. A second

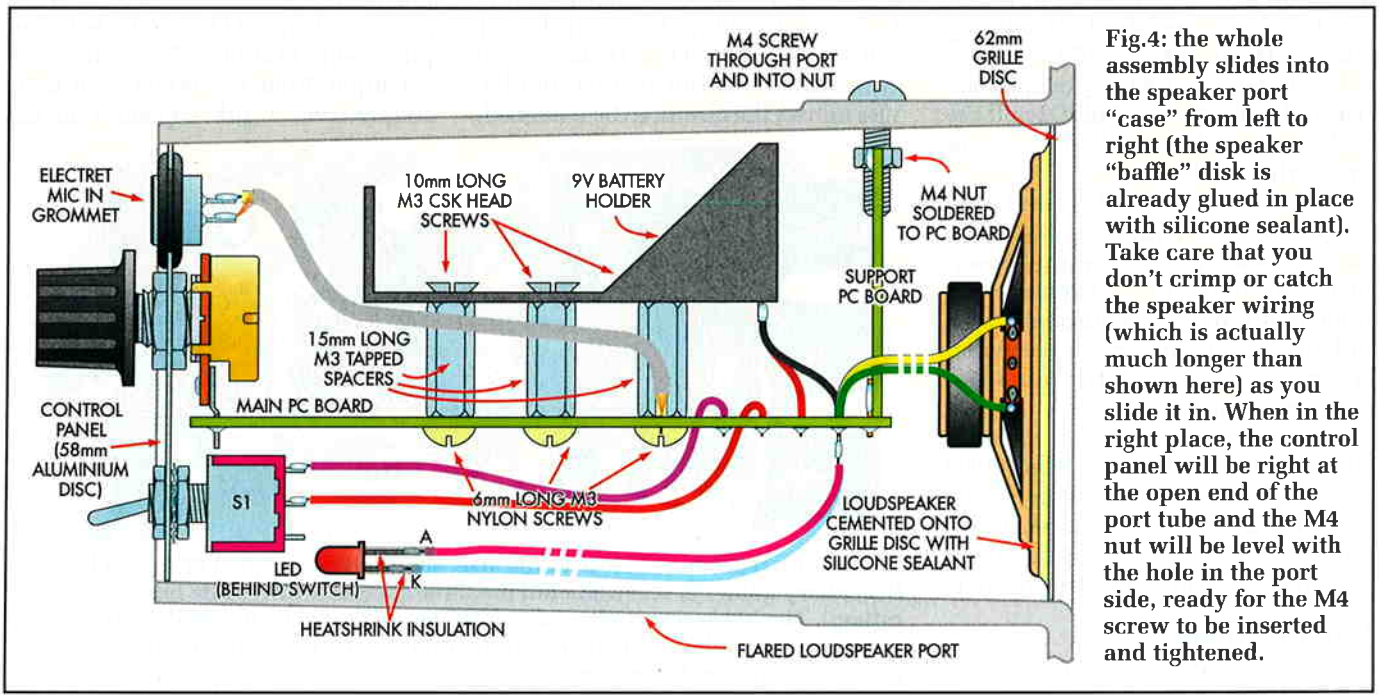



**Fig.4: the whole assembly slides into the speaker port "case" from left to right (the speaker "baffle" disk is already glued in place with silicone sealant). Take care that you don't crimp or catch the speaker wiring (which is actually much longer than shown here) as you slide it in. When in the right place, the control panel will be right at the open end of the port tube and the M4 nut will be level with the hole in the port side, ready for the M4 screw to be inserted and tightened.**

trapezoid-shaped 34 x 55mm PC board, coded 08109062, is used as a support for the assembled project.

An M4 nut is soldered to the top of the support PC board, with a matching hole drilled near the flared end of the tube. An M4 screw passes through this hole into the nut, securing the Galactic Voice components in place within the tube.

The assembled PC board is housed in a flared plastic speaker port tube measuring 58mm diameter x 120mm long.

An aluminium disc is used as the support for the loudspeaker and is secured to the flared end of the tube using silicone sealant. This is 62mm diameter and has holes drilled to make a speaker grille (see fig.5b).

The opposite end of the tube has a similar, though smaller, aluminium disk (58mm diameter) drilled to accept the potentiometers, the switch and LED bezel and for the microphone mounting grommet (fig.5a).

Begin construction by checking the main PC board for any shorts or break in the tracks. Defects in boards these days are rare but if you find any, repair them now to avoid problems at a later stage.

Shorts between tracks can be fixed by scraping between the tracks with a sharp hobby knife. Breaks in tracks can be connected with a layer of solder, with a short length of wire acting as a bridge if necessary.

Insert the low-profile components first such as the links, the diode, the resistors and the ICs. Use the resistor colour code table to help find each value of resistance, and/or check the value using a digital multimeter.

Take care when installing the polarised components (eg, all semiconductors and ICs and electrolytic capacitors) that they are oriented correctly and in the correct position. Solder the components in position and cut the pigtails from the resistors and link from the underside of the PC board with fine, sharp sidecutters.

Now insert the PC stakes. These are located at all the external wiring points and at the four mounting points for the second PC board, at the right hand edge of the main PC board.

Finally, solder in all other on-board components.

Before installing the pots, cut the shafts to length to suit the knobs you are using. Now install the pots taking care to place the log potentiometer in the volume position.

The pots must be earthed to the 0V rail on the PC board with a linking wire from the 0V PC stake soldered to each pot body.

The coating on the pot does not take solder easily – almost certainly, you will need to scrape it away where it is to be soldered to ensure a good attachment for the wire.

## Parts List – Galactic Voice

1 PC board coded 08109061, 93 x 55mm
1 PC board coded 08109062, 34 x 55mm
1 "Galactic Voice" panel label 58mm in diameter
1 flared speaker box port 58mm inside diameter x 120mm long (Jaycar CX-2688 or equivalent)
1 57mm diameter 8Ω loudspeaker
1 miniature electret microphone insert
1 1mm aluminium disc, 62mm diameter
1 1mm aluminium disc, 58mm diameter
1 9V PC mount battery holder
3 knobs to suit potentiometers
1 SPDT toggle switch (S1)
1 rubber grommet with 9.5mm ID hole
1 5mm LED bezel clip
3 M3 tapped x 15mm spacers
3 M3 x 10mm countersunk screws
3 M3 x 6mm Nylon screws (or cut down longer screws)
1 M4 x 15mm screw and nut (brass preferable – see text)
1 50mm length of single core shielded cable
1 400mm length of medium duty hookup wire
1 200mm length of light duty figure-8 speaker wire
1 50mm of 3mm heatshrink tubing
1 60mm length of 0.7mm diameter tinned copper wire
1 150mm cable tie
15 PC stakes

**Semiconductors**
1 LM358 dual op amp (IC1)
1 7555 CMOS 555 timer (IC2)
1 MC1496 balanced mixer (IC3)
1 LM386 1W power amplifier (IC4)
1 1N5819 Schottky Diode (D1)
1 5mm red LED (LED1)

**Capacitors**
1 470µF 16VW PC electrolytic
4 100µF 16VW PC electrolytic
4 10µF 16VW PC electrolytic
1 1µF 16VW PC electrolytic
1 220nF MKY polyester
2 100nF MKT polyester
2 47nF MKT polyester
1 33pF ceramic

**Resistors (0.25W 1%)**
1 470kΩ 3 220kΩ 1 100kΩ 1 39kΩ 2 10kΩ
2 3.3kΩ 1 2.2kΩ 7 1kΩ 1 10Ω
2 10k linear 16mm PC mount potentiometers, (VR1,VR2)
1 10k log 16mm PC mount potentiometer (VR3)
1 50kΩ multiturn top adjust trimpot (VR4)

**Miscellaneous**
Silicone sealant (non-acid cure), black paint

## The hardware

The PC board requires cutouts to allow the M4 nut to be soldered to the PC board and also a notch to allow

(Left): this view shows the business end of the Galactic Voice with a small speaker glued inside the 'grille'. The 'case' is a Jaycar speaker tuning port which just happens to be the right size!

(Right): here's the opposite end. The microphone is located inside the grommet (top) while the three controls are effect, depth and volume. The LED shows that power is switched on.

the matching M4 screw to insert into and through the nut. These cutouts are the non-copper areas shown on the PC board. They can be cut out with a drill and hacksaw and finished with a file.

Solder a brass M4 nut to the top edge of the support PC board as shown. When you solder the nut onto the PC board make sure the inside thread is not soldered.

Fig.5 shows the holes and sizes for the control panel and the speaker "grille" discs. These are made from 1mm aluminium sheet offcuts. Cut out the circle shapes with tinsnips or a hacksaw and file to shape. The front (62mm) disc requires a series of holes, as shown, to allow the sound to escape from the loudspeaker.

We painted the outside face of our grille black using a spray can. When the paint was dry, the loudspeaker was secured to the grille with a smear of silicone sealant around the speaker rim.

Wire up the loudspeaker using 170mm of mini figure-8 speaker wire and secure it around the magnet on the loudspeaker with a cable tie. This will ensure a tug on the wires doesn't break off the lugs on the loudspeaker.

Attach the speaker grille and loudspeaker assembly to the inside of the flared end of the port using silicone sealant.

If you are building from a kit, the disc at the opposite end, the control panel, may already be pre-punched and screen-printed. If not, attach the panel label (Fig. 6) to the control panel and cut the holes out through the panel with a sharp knife.

Place the power switch, the LED bezel and LED in position and insert the rubber grommet in the microphone hole.

Wire the microphone using the shielded cable and then insert the microphone into the rear of the grommet.

Attach the control panel to the PC board and secure it using the potentiometer nuts. Solder the microphone lead to the top side of the PC board (PC stakes) and the LED and switch direct to the appropriate copper pads on the underside of the PC board.

The 9V battery holder is mounted on 15mm long- standoffs and with M3 screws as shown in Fig.4. The three mounting holes in the battery holder are drilled out to 3mm (or 1/8") and counter-bored to suit the M3 countersunk screws.

Nylon screws are used beneath the PC board to prevent shorting the tracks. They can be cut down to 6mm using side cutters. Before mounting, bend the output terminals inward flat against the underside of the holder and solder hookup wire to each terminal. Now attach the holder in place.

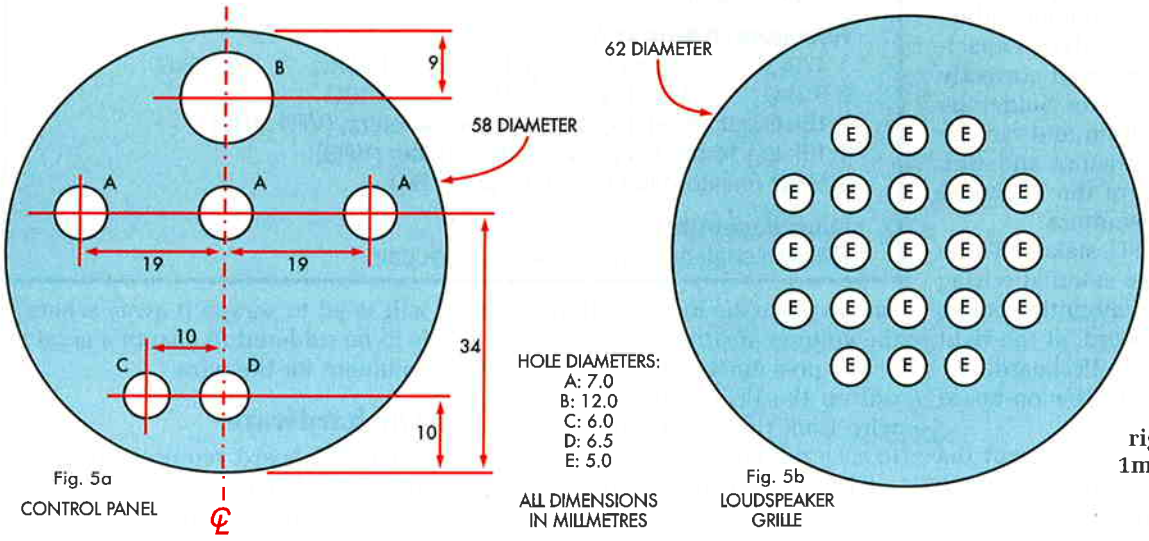



Fig. 5a CONTROL PANEL

Fig. 5b LOUDSPEAKER GRILLE

**The drilling detail for the front (control) panel (fig.5a, left) and the rear (speaker baffle) panel (fig.5b, right). Note that these 1mm aluminium disks are different sizes.**

## Resistor Colour Codes

| | No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|---|
| ☐ | 1 | 470kΩ | yellow violet yellow brown | yellow violet black orange brown |
| ☐☐ | 3 | 220kΩ | red red yellow brown | red red black orange brown |
| ☐ | 1 | 100kΩ | brown black yellow brown | brown black black orange brown |
| ☐ | 1 | 39kΩ | orange white orange brown | orange white black red brown |
| ☐☐ | 2 | 10kΩ | brown black orange brown | brown black black red brown |
| ☐☐ | 2 | 3.3kΩ | orange orange red brown | orange orange black brown brown |
| ☐ | 1 | 2.2kΩ | red red red brown | red red black brown brown |
| ☐☐ | 7 | 1kΩ | brown black red brown | brown black black brown brown |
| ☐ | 1 | 10Ω | brown black black brown | brown black black gold brown |

Wire the the speaker wires to the PC stakes and the battery holder wires to the PC board taking care to make the correct polarity for the connection.

Solder the support PC board at right angles to the main PC board – it solders to the four PC stakes located at the end of the PC board.

A 4mm hole is required to be drilled on the side of the speaker port tube at the flared end 95mm from the non-flared end. This is for the M4 screw to be screwed into the M4 nut on the support PC board.

### Checkout time

Insert the 9V battery and check that the Galactic Voice works by switching on power. You should be able to see the LED flashing and a squeal should come from the loudspeaker if the volume is wound up.

Needless to say, that's feedback caused by the microphone and speaker being in close proximity. But that feedback can also be used to give even more variety to the sound output, especially if adjusted until *just before* audible feedback commences.

**Fig.6: the front panel label we used for the Galactic Voice. A colour copy or printout can be glued to the disk.**

## Capacitor Codes

| Value | (µF value) | IEC Code | EIA Code |
|---|---|---|---|
| 220nF | 0.22µF | 220n | 224 |
| 100nF | 0.1µF | 100n | 104 |
| 47nF | .047 | 47n | 473 |
| 33pF | NA | 33p | 33 |

Try speaking into the microphone and adjust the effects and depth pots to see if they are working.

If the LED doesn't light or if you aren't getting any output, first check the polarity of the wiring. You should also check the parts on the PC board for correct placement and correct orientation for the polarised parts.

Having said that, kit suppliers tell us that 99% of faults in projects are due to soldering problems – particularly dry joints – so if you aren't having any joy, check your soldering again!

Check that power is available between pins 4 and 8 of IC1, pins 1 and 4 of IC2 and pins 4 and 6 of IC4. A fresh battery should give 8.7V across each of these sets of pins.

The Null control is adjusted when VR1 is wound to its maximum (fully clockwise) and the volume turned up but not too high that there is feedback. Adjust VR4 so that no tone can be heard when there is no noise present at the microphone.

Finally, when it all works correctly, the assembly can be slid into the rear of the tube. Note that the speaker wire needs to be kept tight when sliding in so it does not become caught between the rear of the speaker and the support PC board. The wire is tucked in behind the volume potentiometer.

Secure the assembly by screwing the M4 screw into the support PC board's M4 nut after you have lined the two up.

***nuqneH!*** (and if you don't understand what that means, you really need to brush up on your Klingon – otherwise you might make a mistake and be exterminated!) **SC**

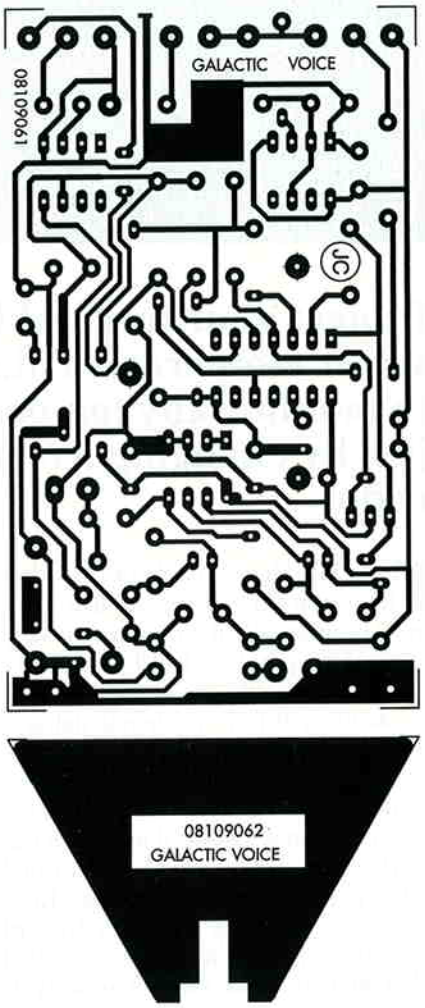



**Fig.7: 1:1 artwork for both of the PC boards with the support PC board at bottom. Note the cutouts needed in this board.**

**Protect your tropical fish with this low-cost water temperature alarm! You can build it to monitor any temperature range you wish, just by changing a couple of lines of software code.**

IT'S COMMON KNOWLEDGE that the water in a tropical fish tank must be maintained within a relatively narrow temperature band – typically around 24°C. In most small home aquariums, this is achieved using a thermostatic heater. When the temperature drops below a preset level, the heater switches on and when it rises above a higher preset, it switches off.

Most aquariums are also equipped with a permanently installed thermometer, allowing the operation of the heating system to be checked at a glance. And that's basically it – nothing more elaborate than this is required while everything is working normally.

But consider the outcome if the heater were to fail due to an open-circuit element, stuck thermostat or extended mains power failure. If a problem like this occurred at an inopportune time such as when you are away on holidays, would the failure go unnoticed by others in the household? And even if you were there, would you detect the problem soon enough to take remedial action?

This is where the Aquarium Temperature Alarm comes in. When the water temperature falls outside a predetermined range, a raucous two-tone alarm sounds to alert anyone in the vicinity of the problem.

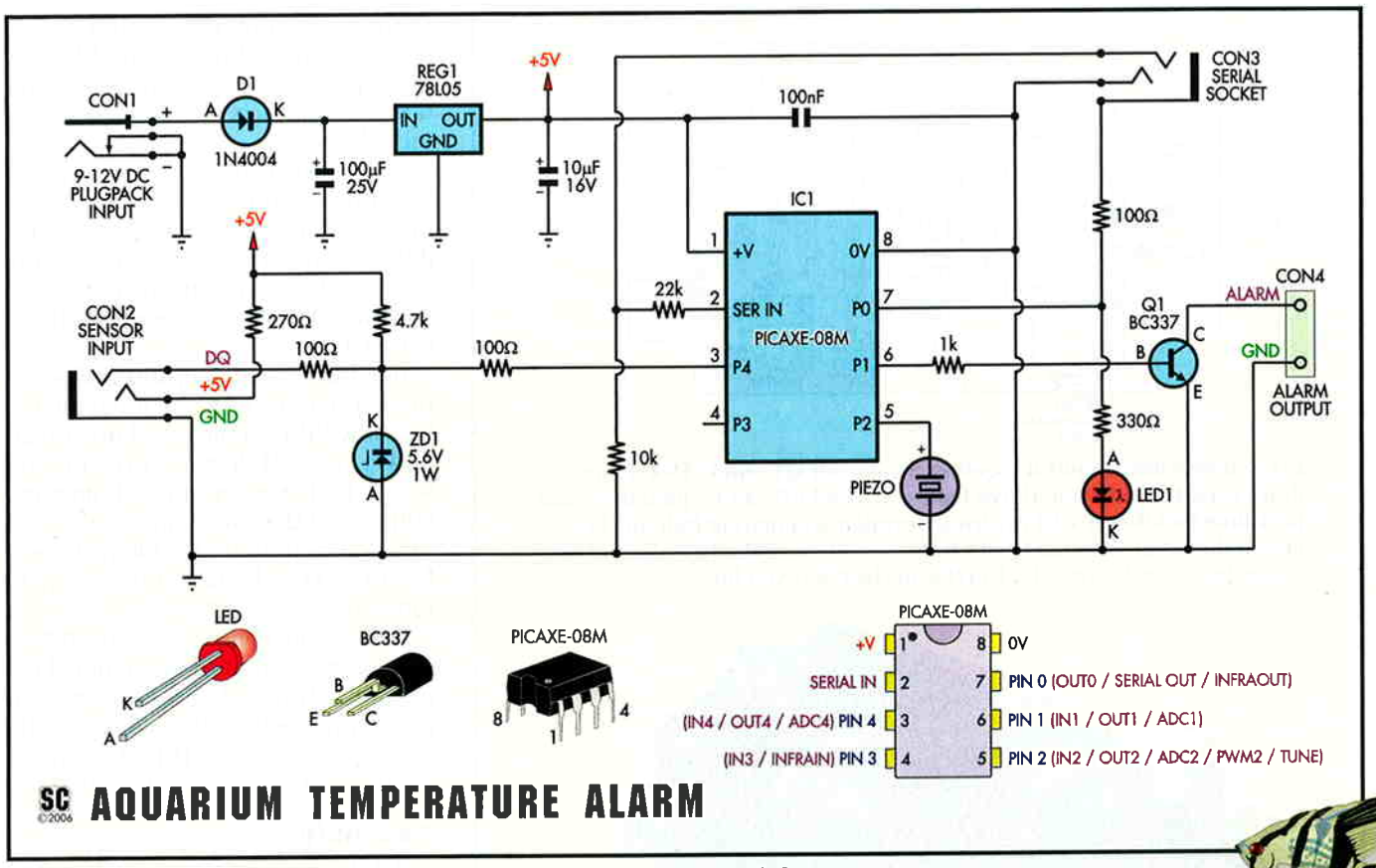
Need more noise? That's not a problem either, as we've made provision for triggering an external alarm system via an optional open-collector output. This could be wired to one sector of a house alarm, which could also power the Aquarium Temperature Alarm for continued monitoring during a mains power failure.

Alternatively, the output could be wired to our SMS Controller project (see the October & November 2004 issues) and/or the PICAXE NetServer (described in this issue) for alerting and monitoring worldwide!

## How it works

The Aquarium Temperature Alarm is based around the popular PICAXE-08M microcontroller from Revolution Education (see Fig.1). Although initially developed for the education market, these versatile little devices are cheap (less than $6) and readily applied to many real-world applications such as our temperature measurement task.

PICAXE micros are very easy to program because you don't need a dedicated programmer – just a serial cable and some free software. This comes in handy if you'd like to pro-




SC ©2006 **AQUARIUM TEMPERATURE ALARM**

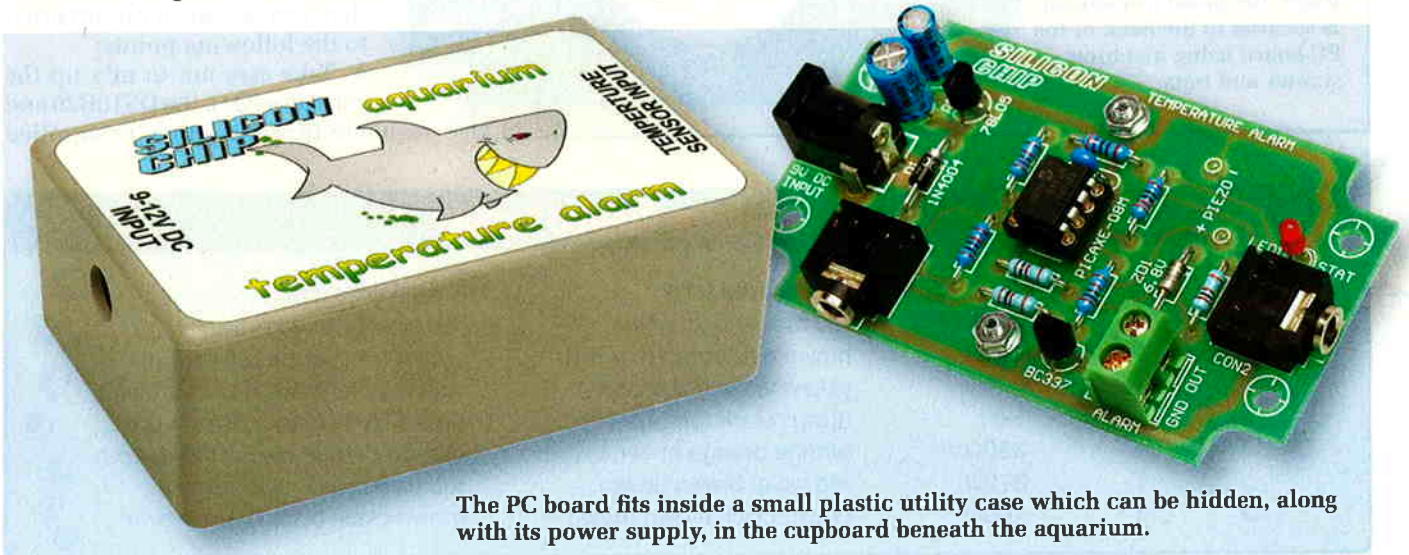
**Fig.1: the circuit diagram reveals a very simple design based around the PICAXE-08M microcontroller. The optional alarm output can be used to trigger an external alarm if you want to make a lot more noise when the programmed temperature limits are exceeded!**

gram the chip for this project yourself and it also allows changes to be made to the temperature range for different applications.

Readers familiar with our previous PICAXE-based projects will immediately recognise the temperature sensor element we've chosen – a DS18B20 device from Dallas Semiconductor. These devices provide "direct-to-digital" temperature sensing, which really just means that they're very easy to use. This is especially true when teamed up with the PICAXE-08M, because it's BASIC language includes a special command for reading the DS18B20's temperature.

The DS18B20 comes in a TO-92 (3-pin) package, which is wired to the end of a 2m-long cable and terminated in a 3.5mm stereo jack. This plugs into a stereo socket (CON2) on the PC board. The DS18B20 is powered from the +5V rail via a 270Ω resistor, which limits transient current should the device be plugged in with power applied.

Temperature data is read from the DS18B20 over the "1-wire" bus, which consists (strangely enough) of just one wire labelled "DQ". This connects to *input4* of the micro via two 100Ω resistors and a 5.6V zener diode. These




**The PC board fits inside a small plastic utility case which can be hidden, along with its power supply, in the cupboard beneath the aquarium.**

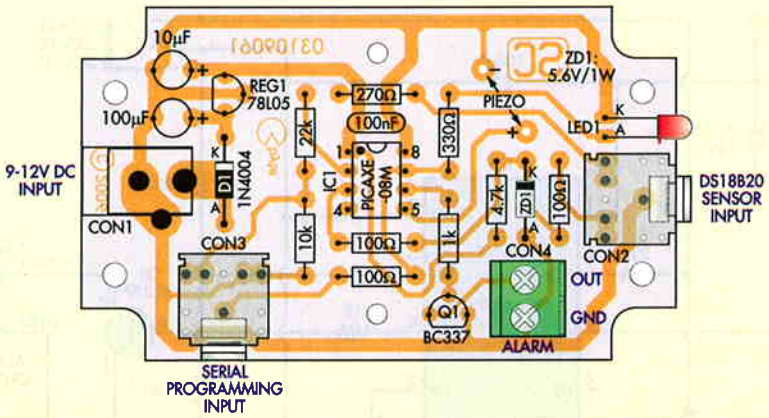
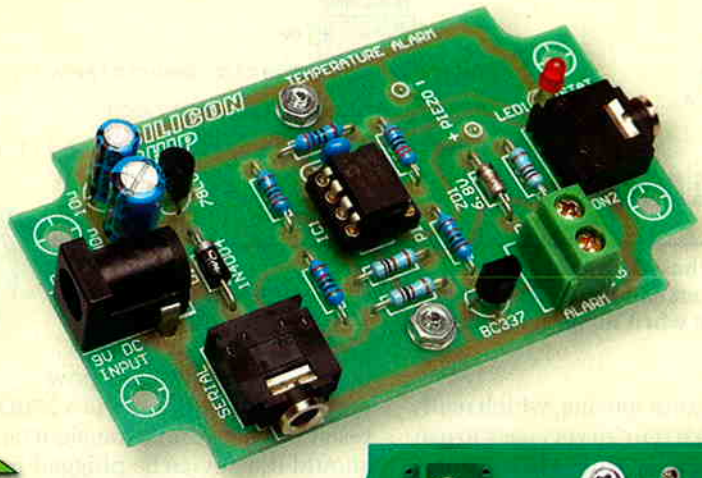
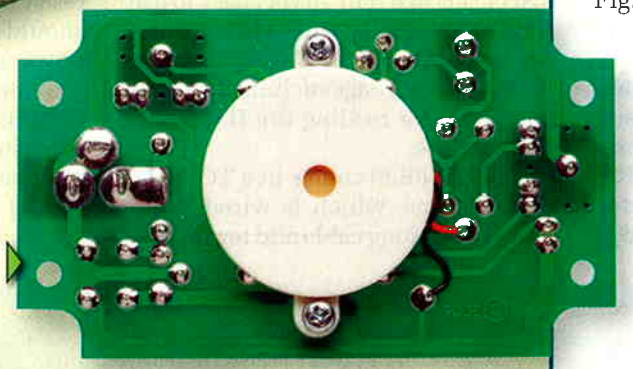



**Fig.2: here's how to put it together. Leave out Q1 and CON4 if you don't need the external alarm features. The LED can be bent over and positioned so that it will protrude through a matching hole in the end of the case. Take care with the orientation of the two electrolytic capacitors, the diodes, Q1, LED1 and the PICAXE chip.**




**Above: the PC board should take less than 30 minutes to assemble. Note that this prototype unit differs slightly from the final version shown in Fig.2.**



**Right: the piezo transducer is secured to the back of the PC board using machine screws and nuts.**

components provide "bullet-proof" antistatic protection for the PICAXE input port – an important consideration if our alarm is to provide long and reliable service.

As is the usual practice, a piezo transducer connected to *output2* produces the noise. A small transistor (Q1) driven from *output1* provides the open-collector output for interfacing with an external alarm, while *output0* drives a LED.

In addition, the *output0* and *serial input* pins are used to program the PICAXE chip via the serial download socket (CON3). These two pins are wired in the conventional manner, with a 22kΩ series resistor used to limit current into the PICAXE port from the PC's higher voltage RS232 interface.

Power can come from any 9-12V DC source, such as an unregulated DC plugpack. Diode D1 provides reverse polarity protection, after which a 7805 3-terminal regulator (REG1) reduces the input to +5V to feed the circuit.

## Assembly

All the components apart from the temperature sensor mount on a small PC board coded 03109061. Assembly is straightforward and shouldn't present any particular problems.

Following the overlay diagram in Fig.2, begin by installing the resistors and diodes. Insert the two diodes (D1, ZD1) so that their banded (cathode) ends are oriented as shown.

Set aside the piezo transducer for now – it must be fitted last. The remaining components can now be installed in any order that you see fit, with attention to the following points:

- Take care not to mix up the transistor (Q1), the DS18B20 and regulator (REG1), as they're supplied

## Table 1: Resistor Colour Codes

| ❑ | No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|---|
| ❑ | 1 | 22kΩ | red red orange brown | red red black red brown |
| ❑ | 1 | 10kΩ | brown black orange brown | brown black black red brown |
| ❑ | 1 | 4.7kΩ | yellow violet red brown | yellow violet black brown brown |
| ❑ | 1 | 1kΩ | brown black red brown | brown black black brown brown |
| ❑ | 1 | 330Ω | orange orange brown brown | orange orange black black brown |
| ❑ | 1 | 270Ω | red violet brown brown | red violet black black brown |
| ❑ | 3 | 100Ω | brown black brown brown | brown black black black brown |

in identical packages. Orient their "flat" faces as shown in Fig.2.

- The 100µF and 10µF capacitors are polarised devices and must be inserted with their positive leads aligned with the "+" markings on the overlay.
- Similarly, the orientation of the 8-pin IC socket is important, so make sure that the notched (pin 1) end is correctly positioned. Don't plug the PICAXE chip in until after the power supply has been checked out!
- Both stereo sockets (CON2 & CON3) have plastic locating pins that must be pushed all the way into matching holes in the PC board. The sockets will sit flush with the PC board surface once these pins are fully engaged.
- We mounted our LED vertically with short lead lengths, which makes it invisible when the assembly is fitted in a case. You may prefer to bend the LEDs leads at 90° so that it can protrude through the end of the case, next to the temperature sensor input. Take care with the orientation of the LED – the anode lead is the longer of the two (see Fig.1).

The piezo transducer mounts on the opposite (copper) side of the board. Begin by sliding an M2.5 x 10mm screw into each of the transducer's mounting holes. Wind up a nut on each screw to act as a spacer and then slip the screws into the two centrally located holes on the PC board. Use flat washers and nuts to secure the assembly in place.

Finally, trim and strip the transducer's wires for connection to the designated pads. Note that the red wire goes to the pad marked "+" in Fig.2, while the black wire goes to "-".

## Making the probe

To make the temperature probe, you'll need a DS18B20 sensor, a 100nF capacitor, about 2m (maximum) of flexible, light-duty 3-core data cable (or similar), a length of 1.5mm heatshrink tubing and some neutral-cure silicone sealant.

A small tube measuring 40-60mm in length is also required to house the sensor. We cut down the barrel of a "BIC" brand ballpoint pen for the job. Thin-walled stainless-steel tubing with an inside diameter of 6-8mm would be even better – just make sure that the tube is large enough to accommodate the chosen cable!

Start by stripping about 20mm of outer insulation from both ends of the cable. Follow this by stripping 5mm of insulation from all three wires at both ends. Tin the bare copper ends, which can then be trimmed to about 3mm.

Choose one end and slip a 10mm length of heatshrink tubing over each wire. Don't shrink it just yet, though! Next, solder the 100nF capacitor to the +5V and GND leads (ie, the outer leads) of the DS18B20 (see Fig.3) and then solder the prepared wire ends to each of the device's leads. That done, slide the heatshrink tubing up over the leads, so as to fully insulate each connection, and carefully shrink it in place.

Next, pass the other end of the cable through the tube housing and connect it to the jack plug, as depicted in

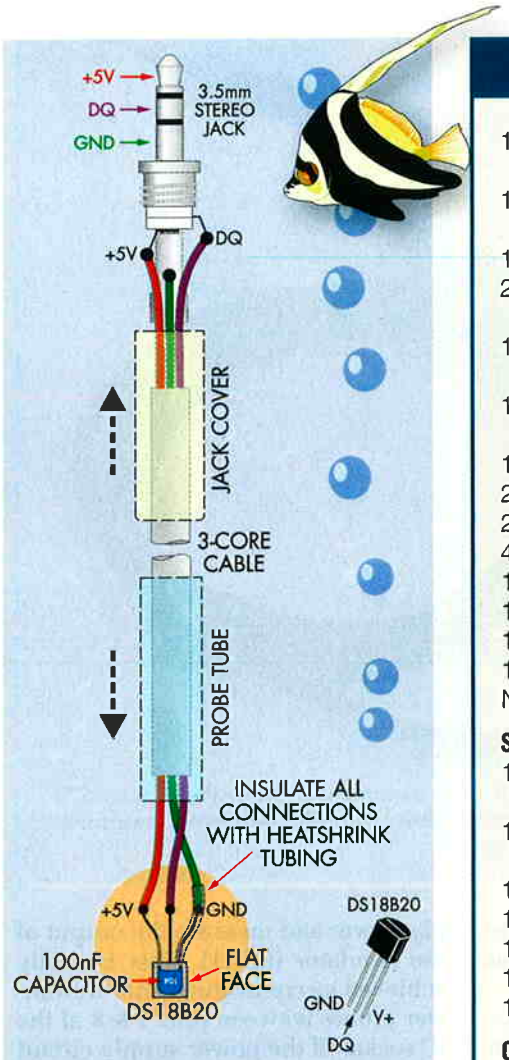



**Fig.3: the DS18B20 is soldered to the end of a 3-core cable and sealed off inside a tube to prevent water ingress. Follow this basic connection diagram, keeping cable length to 2m or less. Be sure to test the sensor before applying the sealant!**

## Parts List

1 PC board, code 03109061, 79mm x 47mm
1 UB5 plastic "Jiffy" box (Jaycar HB-6015, Altronics H-0205)
1 2.1mm DC socket (CON1)
2 3.5mm stereo sockets (CON2 & CON3) (MicroZed CON039)
1 30mm piezo transducer (DSE L-7022, Jaycar AB-3440)
1 2-way 5mm/5.08mm terminal block (CON4) (optional)
1 8-pin IC socket
2 M2.5 x 10mm pan head screws
2 M2.5 flat washers
4 M2.5 nuts
1.5mm heatshrink tubing
1 3.5mm stereo jack
1 2m-length of 3-core data cable
1 probe housing – see text
Neutral cure silicon sealant

**Semiconductors**
1 PICAXE-08M microcontroller (IC1) (MicroZed AXE007M)
1 DS18B20 temperature sensor (MicroZed DS18B20)
1 78L05 +5V regulator (REG1)
1 1N4004 diode (D1)
1 5.6V 1W zener diode (ZD1)
1 BC337 transistor (Q1) (optional)
1 3mm red LED (LED1)

**Capacitors**
1 100µF 25V PC electrolytic
1 10µF 16V PC electrolytic
2 100nF 50V monolithic ceramic

**Resistors (0.25W 1%)**
1 22kΩ
1 10kΩ
1 4.7kΩ
1 1kΩ
1 330Ω
1 270Ω
3 100Ω

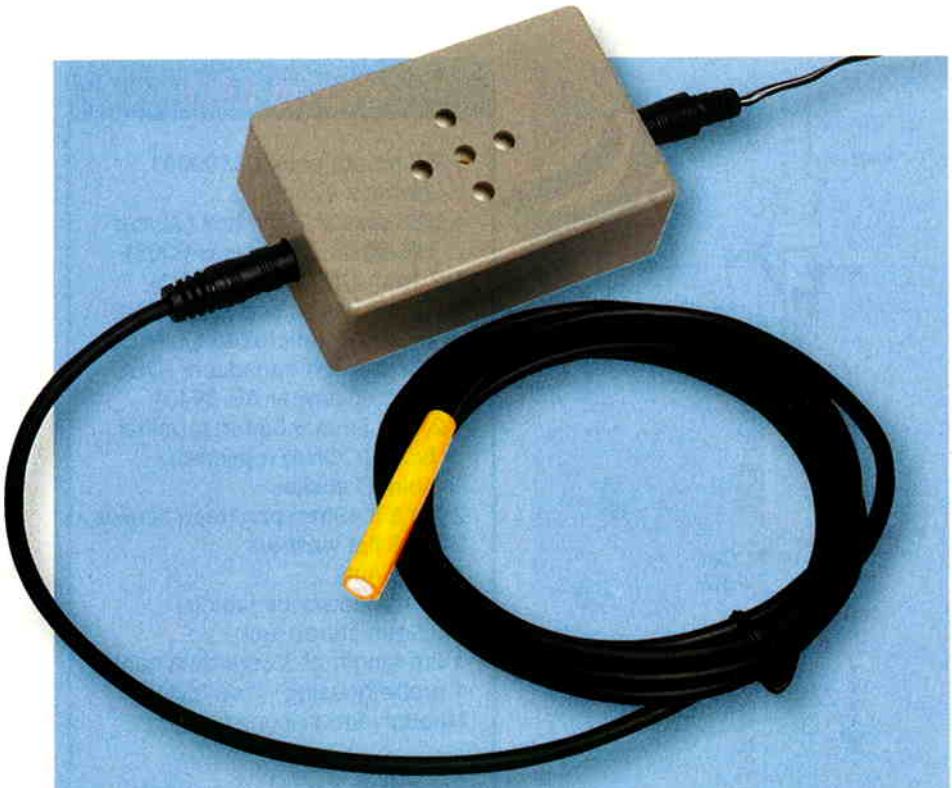
**Also required for programming the PICAXE:**

(1) Serial download cable (MicroZed AXE026)

(2) USB-to-serial adapter (only required if your computer lacks a 9-pin serial port) (MicroZed USB010).

(3) PICAXE Programming Editor software (available free from **www.picaxe.co.uk** or order on CD from MicroZed).

Note: all parts shown with a MicroZed stock number can be ordered from MicroZed Computers, phone 1300 735 420. You'll find their website at **www.microzed.com.au**



**This is the completed unit, together with its temperature probe. You can program it to monitor any temperature range you like (see text), making it suitable for other applications as well.**

**The temperature probe can be hidden behind the inlet hose that runs to the water filter unit and secured using a small cable tie.**

Fig.3. The assembly is now ready to be sealed but be sure to test it first, as set out below!

Once you're sure that it works, squeeze the sensor's leads together and coat the assembly generously with silicone sealant. Force as much sealant as possible into the tube just prior to sliding the sensor inside. Finish by forcing additional sealant into both ends of the tube and clean away any excess before leaving it for 48 hours to completely cure.

## Testing

Without the PICAXE micro in its socket or the sensor connected, apply power and measure the output of the regulator (REG1). This is easily achieved by connecting your multimeter probes between pins 1 & 8 of the IC socket. If the power supply circuit is working correctly, you should get a reading of 4.75-5.25V.

Assuming all is well, disconnect power and insert the PICAXE chip in its socket. Be sure to orient it with its notched (pin 1) end as shown on the overlay diagram (Fig.2). You're now ready to download the program into the PICAXE chip for testing.

## Programming

The BASIC program shown in Listing 1 must now be downloaded into the PICAXE micro to complete the project. You'll need a copy of the PICAXE Programming Editor (available free from **www.picaxe.co.uk**) and a serial download cable (see parts list).

Note that the Programming Editor software must be installed on a PC running Windows 9x/Me/2000/XP with a free 9-pin serial port. If your computer lacks a serial port, then a USB-to-serial adapter is also available.

The accompanying program can either be typed directly into the Programming Editor or you can download it from the SILICON CHIP website – it's in a file named Aquarium_Alarm.zip. Once you have the program loaded, connect the serial cable between your PC and the serial connector (CON3) on the alarm PC board.

Power up the alarm and hit the "Run" button in the Programming Editor. This will download the program into the PICAXE. If the sensor isn't connected, the alarm should immediately begin to sound off!

Even with the sensor connected, the alarm may sound as soon as power is applied – depending on the ambient temperature. Try gently heating or cooling the sensor to prove that it is working. In some climates, varying the MIN_TEMP and MAX_TEMP values may also prove helpful during testing.

Note that it's good practice to power off the alarm when connecting and disconnecting the sensor. Once you've

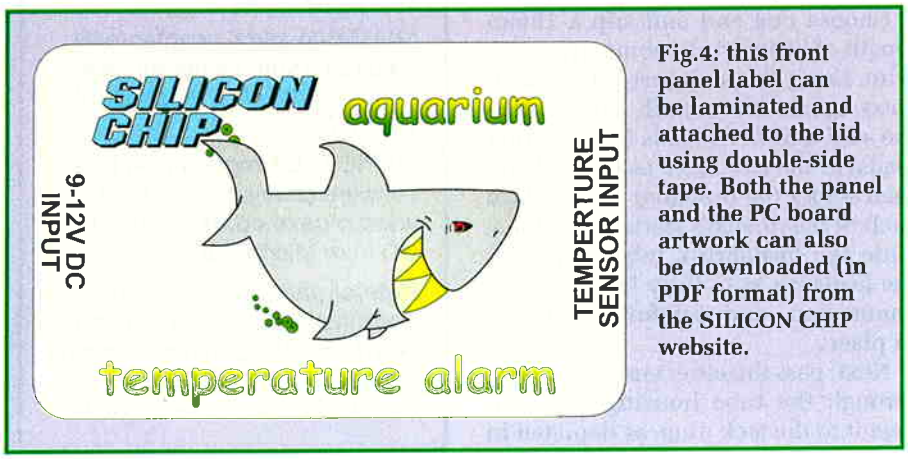



**Fig.4: this front panel label can be laminated and attached to the lid using double-side tape. Both the panel and the PC board artwork can also be downloaded (in PDF format) from the SILICON CHIP website.**

**It's easy to spend several hundred dollars stocking a large tank like this one. Fitting a temperature alarm will help protect your investment.**

proven that it works, seal the sensor and all exposed connections from exposure to water as described in the "Making The Probe" section.

## Housing & installation

The completed assembly is designed to fit in a UB5-sized plastic "Jiffy" box. Holes will need to be drilled in either end of the case to accommodate the sensor input socket (CON2) and LED and to allow entry of the DC jack. An additional hole will also be needed if you intend to wire up an external alarm system to the open collector output at CON4.

Several holes should also be drilled in the underside of the case to let the sound from the piezo transducer out. As always when drilling soft plastics, start with a small pilot hole and gradually increase to the final diameter using several drill sizes. A tapered reamer is handy for finishing off larger holes.

Note that as the programming socket (CON3) is intended for use only during project construction, it is set back from the edge of the PC board and cannot be accessed from outside the case – so do not drill a hole for it!

Guides integral to the case should wedge the board in place, alleviating the need for mounting screws. If your board isn't a firm fit in the case, then several blobs of hot-melt glue (or silicone sealant) can be used to fix it in place.

The temperature sensor should be positioned so that it is fully immersed in the tank. It can be fastened to existing tubing or a suction cup or two can be used to hold it in place.

## Other uses

The program presented in Listing 1 is extremely simple and its operation self-evident. The upper and lower temperature limits are easily altered, if desired. The project could easily be modified for other, similar applications requiring temperature monitoring. It could even be used for rudimentary control using the transistor output to switch an external device.

Operating range of the DS18B20 temperature sensor is -55°C to +125°C. However, care should be exercised when choosing materials for the probe housing and wiring, all of which must be designed to withstand the expected temperatures.

Note that we've used the **readtemp** command in our program, which returns the temperature as a whole degree. For more demanding applications, experienced programmers may wish to use the **readtemp12** command instead to obtain measurements to 0.5°C, as measured by the DS18B20.

Refer to the "Humidity.bas" program, published as part of the "PICAXE-18X 4-channel Datalogger" project (January-March 2004) for an example of how to use the **readtemp12** command. The "Humidity.bas" program can be obtained from the March 2004 download section of our website. You'll also need the DS18B20 datasheet, available from **www.maxim-ic.com**.

If you'd like to know more about PICAXE microcontrollers, you'll find comprehensive documentation in PDF format at **www.picaxe.co.uk**. Beginners will also be interested in our "PICAXE In Schools" series, starting in the May 2005 edition. Back issues are available from our subscriptions department (see the subscriptions page in this issue). **SC**

### Listing 1: Aquarium Alarm

```
' Aquarium Alarm  v1.0 28/06/06
' PICAXE-08M

' Define temperature limits

symbol MIN_TEMP = 22   'for tropical fish tank
symbol MAX_TEMP = 27

' Pin definitions

symbol LED = 0
symbol ALARM_OUT = 1
symbol PIEZO = 2
symbol SENSOR = 4

let dirs = %00000111

main:
  readtemp SENSOR,b1
  if b1 < MIN_TEMP then goto alarm
  if b1 > MAX_TEMP then goto alarm
  low ALARM_OUT
  high LED
  pause 100
  low LED
  sleep 3
  goto main

alarm:
  high ALARM_OUT
  tune 1,8,($44,$40,$44,$40,$44,$40,$44,
$40,$44,$40,$44,$40,$44,$40,$44,$40,$44,
$40,$44,$40,$44,$40,$44,$40)
  goto main
```

SEPT' 06

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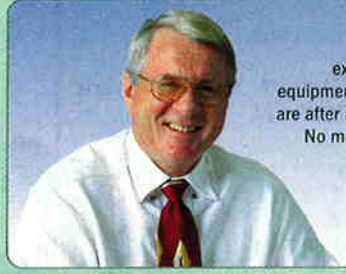

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**Jack O'Donnell** - Managing Director

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NEW Only available at Altronics!

*(SC June '06)* ***ATTENTION: AV Installers, Service Technicians, Television Repair People!***

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A must have for video servicing and trouble shooting in the field or workshop!

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Colour Bars | Dots | Grid | Red | Blue | Green | White | Black | Pluge/2T Pulse & Bar

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**(SC Oct'03)**
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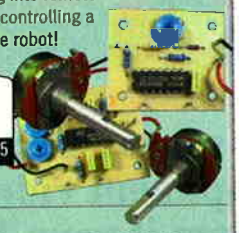

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Z 0253 Blue
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$16.50 Z 0261 RRP $19.95

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by JIM ROWE

# S-video to composite video converter

**Some digital TV set-top boxes provide only S-video and component video outputs, which can pose a problem if your TV set only has a composite video input – or you've used up the S-video and component video inputs. The same can happen with video tuner cards for PCs. Here's an easy-to-build adapter to get you out of trouble.**

YOU CAN BUY CHEAP S-video to composite video adapters in bargain stores but the unit described here will do a much better job.

Although those really cheap bargain-store adapters do work, if you examine the pictures critically, you'll find that their quality leaves quite a bit to be desired. In particular, you'll find that wherever the image has large areas of fine detail – like a shirt with a fine striped or check pattern, or an exterior panning shot of a multi-sto-

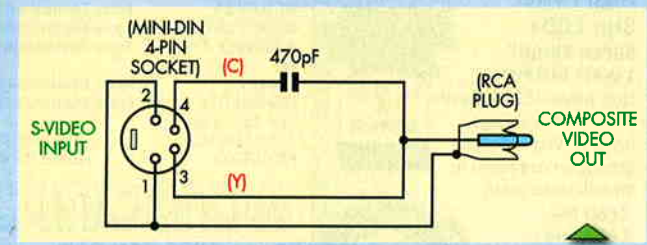



**Fig.1: adding a low-value capacitor in series with the chrominance signal at the S-video input can reduce cross-colour interference but also softens the picture.**

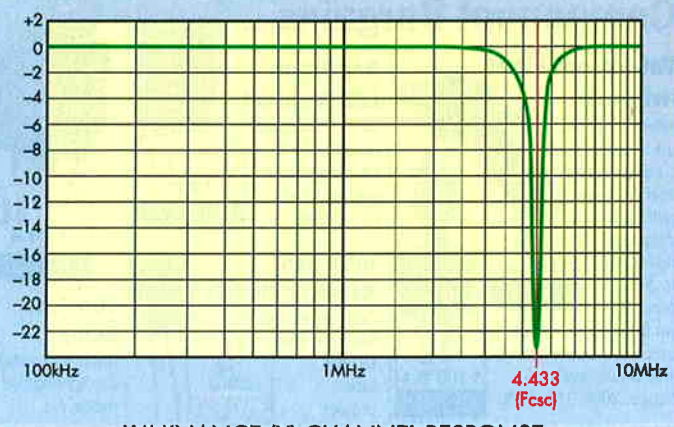



**Fig.2 (right): the unit described here uses an LC circuit to notch out a narrow band of frequencies centred on the 4.433MHz colour subcarrier frequency. This reduces cross-colour interference while leaving a sharp picture.**

**Low-cost "bargain-store" adapters commonly produce pictures that suffer from cross-colour interference, as shown in the photograph at left. By contrast, the SILICON CHIP converter dramatically reduces cross-colour interference – see photo at right.**

rey building – then you'll see a very obvious coloured Moire interference pattern, usually in shades of yellow and purple.

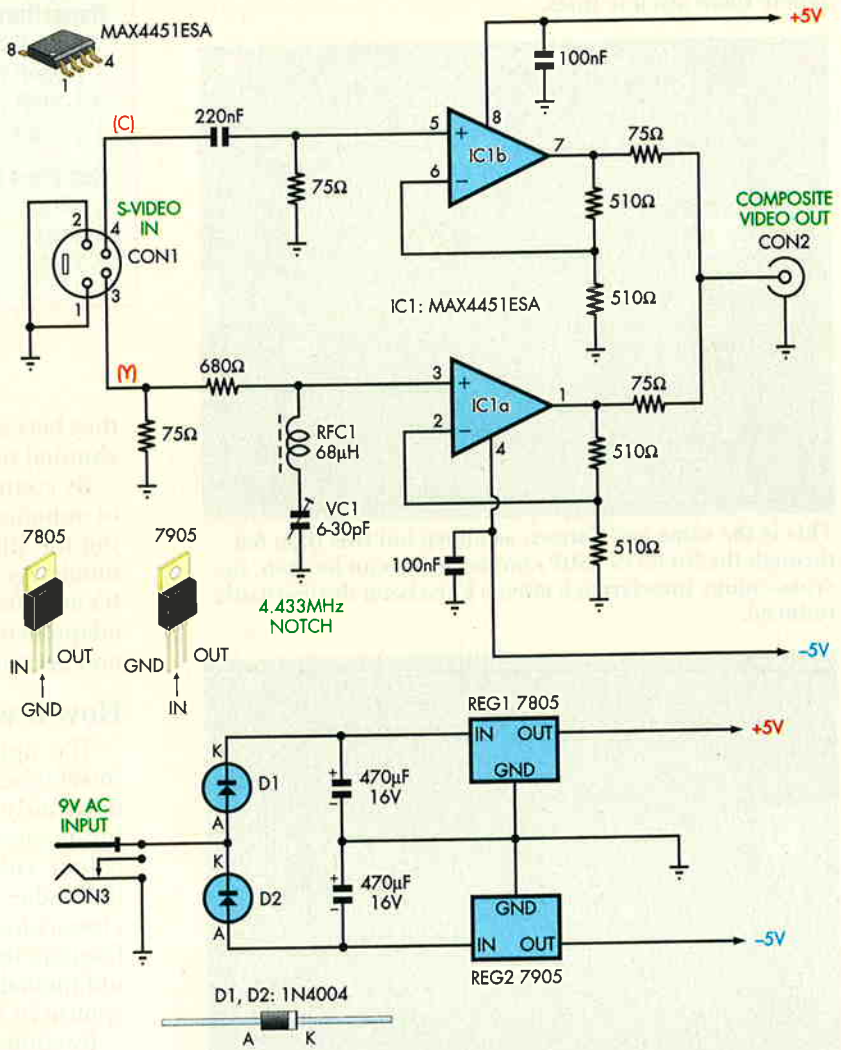
This effect is called "cross-colour interference" and it's caused by heterodyne beats between the higher frequencies in the luminance (Y) signal and the chrominance (C) subcarrier in the receiver's decoder. In effect, the higher luminance frequencies tend to behave as if they were part of the chrominance signal and as a result, produce fake colour patterns.

This happens when the two signals are simply mixed together in the video adaptor – which is what commonly happens in the bargain store units. This interference pattern can't happen when the Y and C signals are kept separate, which is why S-video produces much better image quality.

## Reducing the interference

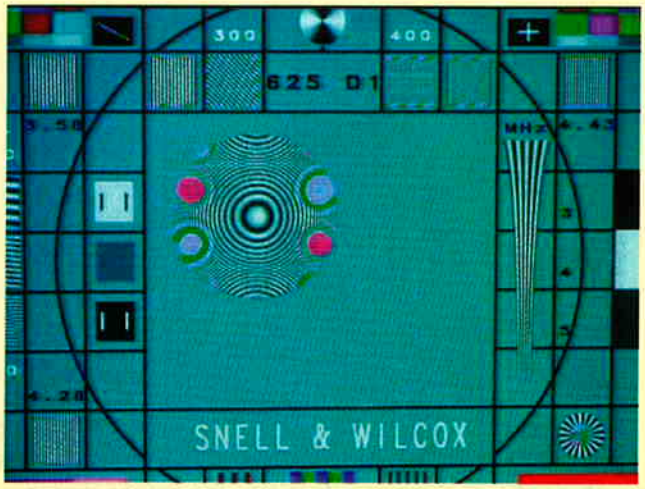
Some of the better low-cost adaptors try to reduce this cross-colour interference by adding a small capacitor in series with the chrominance input signal, as shown in Fig.1. The capacitor's value is chosen so that it passes most of the chrominance (C) information (it's in a band about 2.5MHz wide, centred on 4.43361875MHz) while at the same time attenuating the higher frequency luminance signals – ie, by shunting the luminance output into the chrominance output of the S-video signal source.

This reduces the cross-colour interference although it also removes some of the fine detail from the images, so



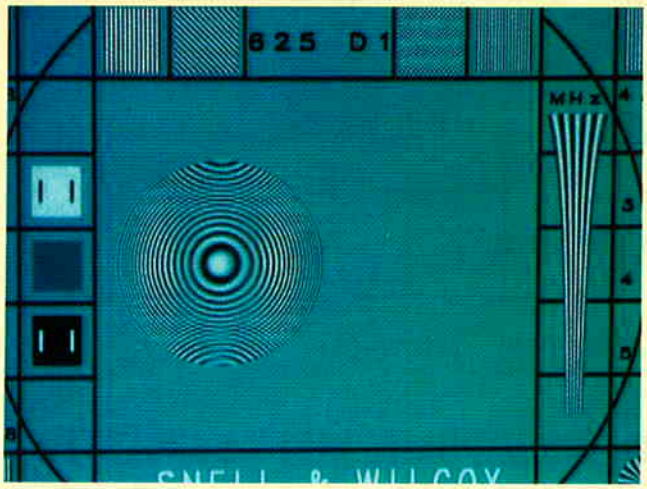

**SC ©2006 S-VIDEO TO COMPOSITE VIDEO CONVERTER**

**Fig.3: the circuit is based on a MAX4451 dual-wideband video amplifier, with each stage wired as a non-inverting amplifier with a gain of 2.0. RFC1 and VC1 provide the 4.43361875MHz notch in the luminance signal.**




**This screen shot shows the Snell & Wilcox moving plate test pattern as fed through an "el-cheapo" S-video to composite video converter. Note the obvious colour Moire patterns on the moving plate section and in other areas where there are fine lines.**

**This is the same test pattern as above but this time fed through the SILICON CHIP converter. As can be seen, the cross-colour interference effects have been dramatically reduced.**




**By way of comparison, this is the direct S-video signal. It's completely clear of cross-colour interference effects and clearly demonstrates the advantages of S-video.**

## Parts List

1 PC board, code 02109061, 76 x 46mm
1 UB5 jiffy box, 83 x 53 x 31mm
1 68µH RF choke (RFC1)
1 mini 4-pin DIN socket, PC-mount (CON1)
1 RCA socket, yellow, PC-mount (CON2)
1 2.5mm concentric power connector, PC-mount (CON3)
4 M3 x 10mm machine screws, countersink head
4 M3 star lockwashers
10 M3 nuts
2 M3 x 6mm machine screws, round/pan head

**Semiconductors**
1 MAX4451ESA dual video op amp (IC1)
1 7805 +5V regulator (REG1)
1 7905 -5V regulator (REG2)
2 1N4004 diodes (D1,D2)

**Capacitors**
2 470µF 16V RB electrolytic
1 220nF MKT metallised polyester
2 100nF multilayer monolithic
1 6-30pF trimcap, green (VC1)

**Resistors (0.25W 1%)**
1 680Ω
4 510Ω
4 75Ω

they become softer – ie, the chrominance output is also shunted to some extent.

By contrast, the unit described here does a better job of reducing cross-colour interference without sacrificing the higher frequencies in the Y signal nearly as much. As a result, the images stay reasonably sharp. It's admittedly a bit more complex than the "el-cheapo" adaptors but it's still low in cost and very easy to build and get going.

## How it works

The approach taken here to reduce cross-colour interference is to use a simple LC trap circuit to notch out a fairly narrow range of frequencies in the incoming luminance (Y) signal, centred on the 4.43361875MHz colour subcarrier frequency. This removes most of the higher luminance frequencies that cause obvious cross-colour patterning, while leaving the luminance frequencies below about 3.5MHz and above 5.4MHz untouched. You can see the resulting luminance response in Fig.2.

By contrast, the incoming chrominance signal passes through its channel largely untouched, so there's no degradation of colour detail. As a result, the image quality of the composite video output signal is quite good. Of course, it's not as good as watching S-video directly but it's noticeably better than you get with an "el-cheapo" adaptor.

## Table 1: Capacitor Codes

| Value | µF Code | EIA Code | IEC Code |
|---|---|---|---|
| 220nF | 0.22µF | 224 | 220n |
| 100nF | 0.1µF | 104 | 100n |

Now let's take a look at the circuit diagram – see Fig.3. As shown, the incoming S-video (Y/C) signals come in via CON1, a standard 4-pin mini-DIN socket. The C signal is then fed through a 220nF coupling capacitor and is terminated by a 75Ω resistor to prevent ringing due to cable reflections.

From there, the signal is fed to pin 5 of IC1b which is one half of a MAX-4451 dual-wideband video amplifier wired here as a non-inverting amplifier with a gain of 2.0. This gain is necessary to allow for mixing and output cable back-termination losses.

The incoming Y signal is treated a little more harshly. After being terminated in the correct 75W impedance, it's then passed through the "notch" circuit. This consists of a series 680Ω resistor and a series LC tuned circuit formed by a 68µH RF choke (RFC1) and a 6-30pF trimmer capacitor (VC1). When VC1 is adjusted to resonate with RFC1 at 4.43361875MHz, this LC circuit forms a low-impedance path to earth at that frequency. This acts together with the 680Ω series resistor to produce the desired notch in the response, as shown in Fig.2.

From there, the rest of the Y signal is passed through IC1a, the other half of the MAX4451 device which is also wired as a non-inverting amplifier with a gain of 2.0. The outputs of both IC1b and IC1a are then mixed using the two 75Ω output back-terminating resistors, to produce the final composite video output signal at output connector CON2.

### Power supply

The MAX4451 IC needs a DC supply of ±5V and this is provided using the simple power supply shown at the bottom of Fig.3.

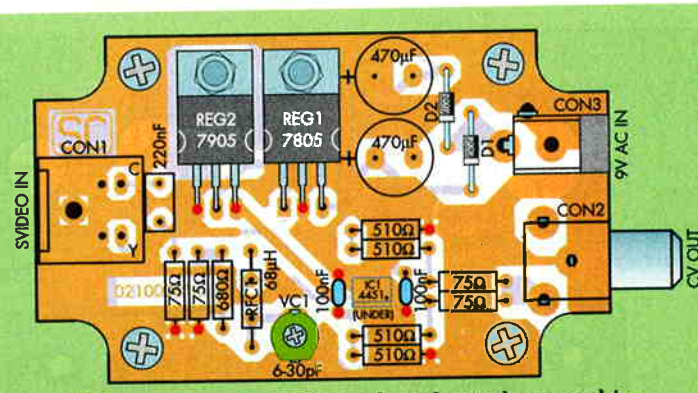



**Fig.4: install the parts on the PC board as shown here, making sure that all polarised parts are correctly orientated. The leads designated with a red dot must be soldered to both sides of the board but only if your board doesn't have plated-through holes.**

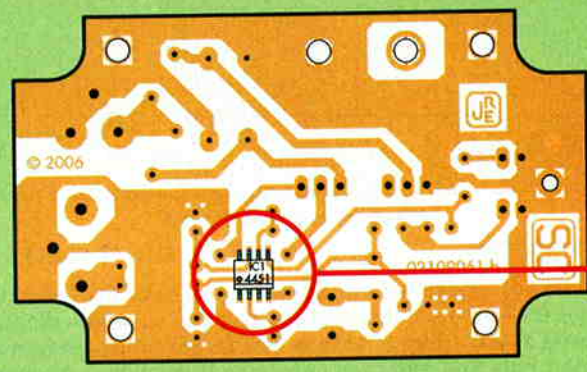
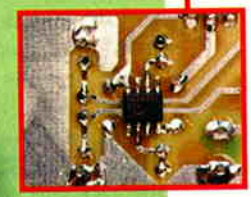
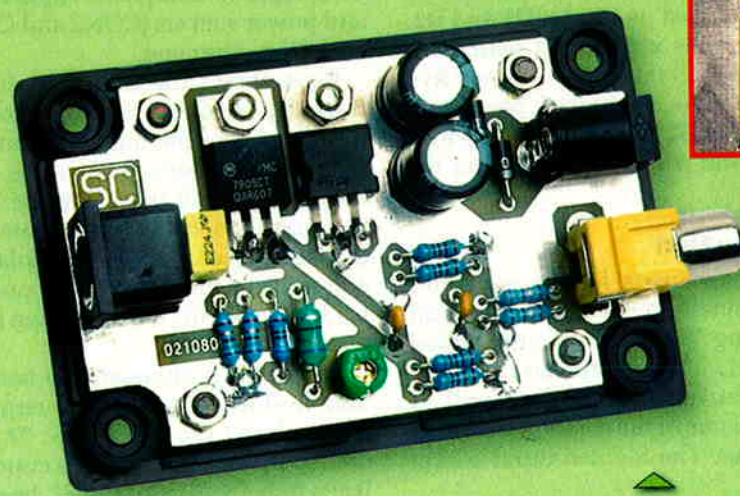



**Fig.5: the MAX4451 comes in an SOIC-8 package and is mounted on the underside of the PC board as shown above and in the photo below right. Be sure to mount it with its chamfer side towards the bottom and use a soldering iron with a very fine chisel-tip to solder its leads.**






**This is the fully-assembled PC board, mounted on the lid of the case. Power comes from an external 9V AC plugpack.**

## Table 2: Resistor Colour Codes

| ❑ | No. | Value | 4-Band Code (1%) | 5-Band Code (1%) |
|---|---|---|---|---|
| ❑ | 1 | 680Ω | blue grey brown brown | blue grey black black brown |
| ❑ | 4 | 510Ω | green brown brown brown | green brown black black brown |
| ❑ | 4 | 75Ω | violet green black brown | violet green black gold brown |

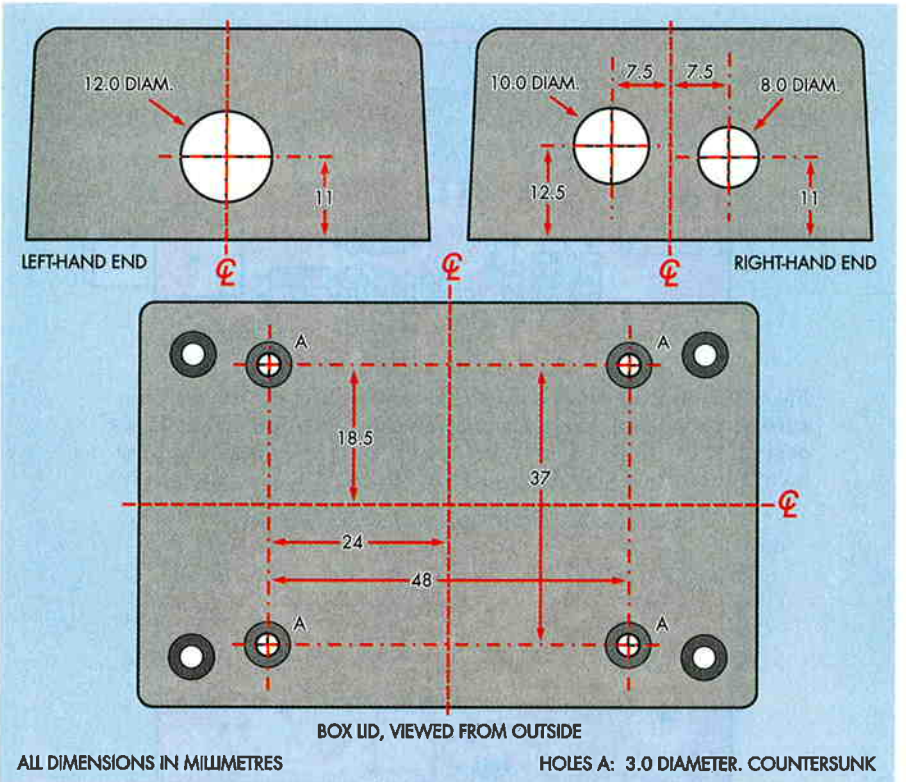



**Fig.6: follow this diagram to mark out the holes to be drilled in the ends of the box and the box lid. Alternatively, you can scan this diagram, print it out and use it as a drilling template. The larger holes are best made by drilling a small hole first and then enlarging them using a tapered reamer.**

Power comes from a 9V AC plugpack supply and this feeds two half-wave rectifiers based on diodes D1 and D2. Their outputs are filtered using two 470µF capacitors and fed to positive and negative 3-terminal regulators REG1 & REG2. REG1 then provides the +5V rail while REG2 provides the -5V rail.

## Construction

All of the parts for the converter fit on a small double-sided PC board measuring 76 x 46mm and coded 02109061. This board has rounded cutouts in each corner, so it will fit snugly in one of the small plastic UB5 jiffy boxes. The S-video input socket CON1 is at one end of the board and box, while the composite video output and power sockets (CON2 and CON3) are at the other end.

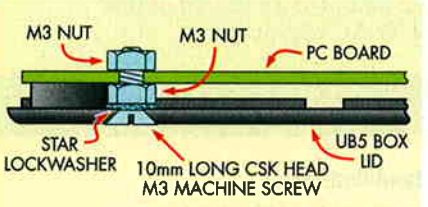



**Fig.7: the PC board is mounted on the lid using M3 x 10mm machine screws, nuts and lockwashers.**

Fig.4 shows the assembly details. Begin by checking the hole sizes for the three connectors and enlarge these if necessary. That done, start the assembly by installing the resistors and the capacitors. Note that the two 470µF electros are polarised and must be fitted with their positive leads towards the left, as shown in the overlay diagram.

By the way, although the board is double sided, it may not be supplied with plated-though holes. In that case, you must solder the component leads to both sides of the PC board in those locations marked with a red dot on Fig.4. That way, the component leads themselves make the necessary connections between the two sides of the board.

Trimmer capacitor VC1 can go in next, noting that its flat side goes towards the bottom of the board. Follow this with the 68µH RF choke (RFC1) – the PC board can accept either an axial-lead or "single-ended" choke, so use whichever set of holes is the most convenient for the part supplied.

Next, fit diodes D1 and D2, followed by regulators REG1 and REG2. The latter are both installed with their leads bent downwards by 90° about 6mm from their bodies. Slip them into the positions indicated, then fasten their metal tabs to the PC board using M3 x 6mm machine screws and nuts before soldering their leads.

It's important not solder the leads before the metal tabs are secured. If you do, the solder joints could fracture (or the copper tracks could lift) as the nuts are tightened. Take care also to use the correct regulator type in each position (REG1 is a 7805 type while REG2 is a 7905).

Now for the dual video op amp (IC1). This comes in a very small SOIC-8 surface-mount package and is mounted on the underside of the board – see Fig.5. Note also that it's mounted with its chamfer and notch side towards the bottom edge of the board.

Because its leads are spaced just 1.25mm apart, you need to take great care when soldering them to the copper pads. Be sure to use a soldering iron with a very fine chisel-tip and make sure the tip is very clean.

Soldering this type of device in place is also much easier if all its board pads are lightly tinned first. That done, place the device and its leads carefully over the pads and hold it in place with a toothpick (or "crossover" tweezers) while you just touch the tip of the iron to one lead for a second or two, to melt the solder underneath.

This should then be sufficient to hold the device in place while you solder all the other leads to complete the job.

The board assembly can now be completed by turning it back over and fitting the three connectors (CON1-CON3).

## Final assembly

The PC board fits neatly into a UB5-size plastic box but first you have to drill the various holes in the box and its lid.

Fig.6 shows the locations and sizes of these holes. There are only seven holes in all: four in the lid for the PC board mounting screws and three larger holes in the box ends for the connectors.

Once these holes have been drilled, mount the PC board on the inside of

the lid using four M3 x 10mm machine screws with countersink heads – see Fig.7. Note that each screw has an M3 star lockwasher fitted to it first, after which a nut is fitted and tightened to secure it in position.

In practice, these nuts act as spacers which raise the PC board about 3mm from the lid (which is used here as the base). Once all the screws are in position, slip the PC board into place and secure it with the four remaining nuts.

## Notch adjustment

The luminance notch trap can either be set visually or you can use an RF signal generator and an oscilloscope.

If you have access to the required test instruments, simply set the RF generator to 4.43361875MHz (use a frequency counter to do this if necessary) and feed its output into the Y signal input – ie, pin 3 of CON1 (or the junction of the 75Ω and 680Ω resistors). That done, use your scope to monitor the signal level at the composite video output of the converter (the centre pin of CON2) and adjust trimcap VC1 carefully until you see the signal level drop down into a sharp null.

The correct setting for VC1 is right at the bottom of that null.

Of course, you won't be able to set the notch frequency this accurately if you don't have access to test instruments. In that case, you'll have to set it visually, with the converter operating on a suitable S-video signal from your set-top box or a DVD player.

Try to pick a scene where there is some cross-colour patterning visible in the images. It's then just a matter of slowly and carefully adjusting VC1 with an alignment tool or jeweller's screwdriver until the cross-colour "nasties" disappear.

Note that you may need to repeat this procedure a few times, until you're confident that you've found the correct setting.

Finally, the box can be slipped over the lid assembly and secured using the small self-tapping screws provided. That's it – you're now ready to connect your set-top box or DVD player, etc to your TV's composite video input via your new adapter. SC

**Fig.8: this full-size artwork can be cut out and attached to the lid of the case. A single layer of clear, wide adhesive tape will protect it from damage. Alternatively, you can download both this and the PC board artwork (in PDF format) from the SILICON CHIP website.**


$10000 PRIZE POOL!

# 2006 SILICON CHIP
## Excellence in Education Technology Awards
### CLosing Soon

**SILICON CHIP's Excellence in Education Technology awards carry a prize pool of $10,000. Separate awards will be made to students of secondary schools throughout Australia and to students of universities and TAFE colleges throughout Australia.**

**The secondary school awards have three categories:**

**(a) Best final year assignment of an individual student involving electronics technology.**
**(b) An award to the school sponsoring the winning individual student.**
**(c) Best school project involving electronics technology.**

**The university and TAFE college awards have three categories:**

**(a) Best project from a student as part completion of a degree, diploma or certificate in electronics or a related field (ie, mechatronics).**
**(b) Best research project from a post-graduate student working in an area of applied electronics.**
**(c) An award to the university faculty or school sponsoring the best research project.**

**Entries and judging**

**The awards will be judged by the editorial staff of SILICON CHIP, convened as a judges panel. The decisions of the judges will be final. Entry requirements are as follows:**
**(1) A description of the project in no more than 1000 words.**
**(2) Full circuit and wiring diagrams, performance plots, etc.**
**(3) Good quality photographs to show all visual aspects of the project.**
**(4) Details of software.**

**Entries for the 2006 awards close on October 16th, 2006. All submissions will be confidential, until the winners are announced, in the December 2006 issue of SILICON CHIP.**

**Each award will take the form of a cash prize and a commemorative plaque. All enquiries about these awards should be directed to the editor via email to: awards@siliconchip.com.au**

# CIRCUIT NOTEBOOK

**Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.**

## Improved delay circuit for power windows

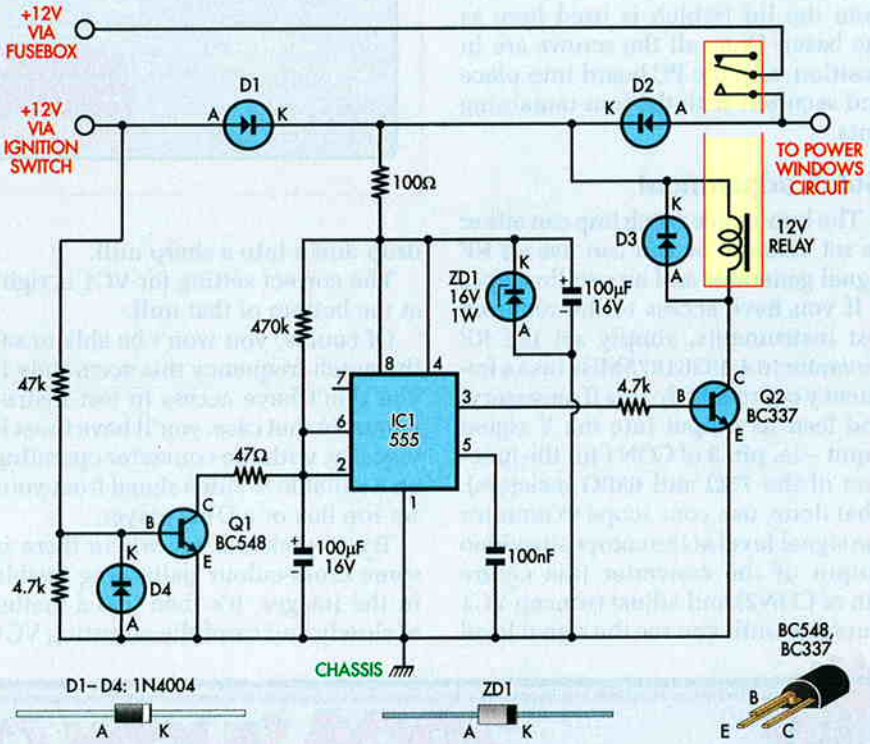
Here's an improved version of the delay circuit published in the March 2005 edition. This incarnation uses only one 555 timer and unlike the original circuit, it draws no current when the ignition is switched off. It also eliminates the need to discharge a large capacitor (100µF) into pin 7, which is known to cause damage to some variants of the 555 chip.

When the ignition is switched on, the 100µF timing capacitor is held discharged by Q1, which is biased on. The output (pin 3) of the 555 is high, switching on Q2 and energising the relay. This supplies 12V to the power windows circuit via the relay contacts.

When the ignition is switched off, the circuit remains powered via D2 and the contacts of the relay. However, the base biasing circuit for Q1 is now isolated by diode D1, so the transistor no longer conducts.

The 100µF capacitor begins to charge and after about 40 seconds, the voltage applied to pins 2 & 6 reaches the threshold level and the 555 output (pin 3) swings low. This switches Q2 off, disables the relay and removes power from the entire circuit.

**Murray McGregor, Dunedin, New Zealand. ($35)**



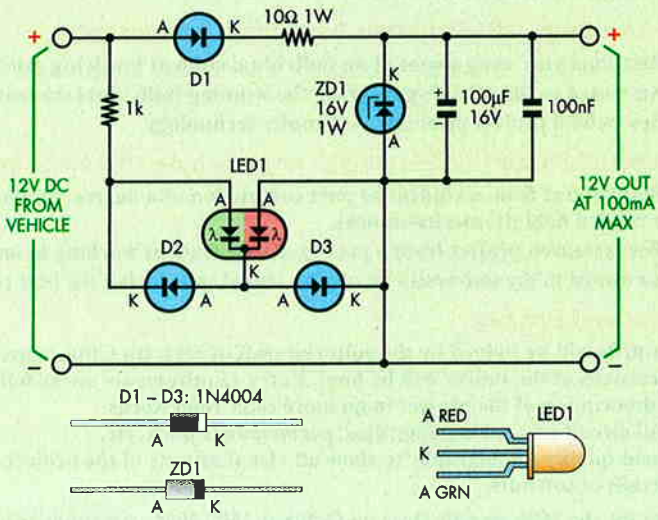

## Protected 12V automotive supply

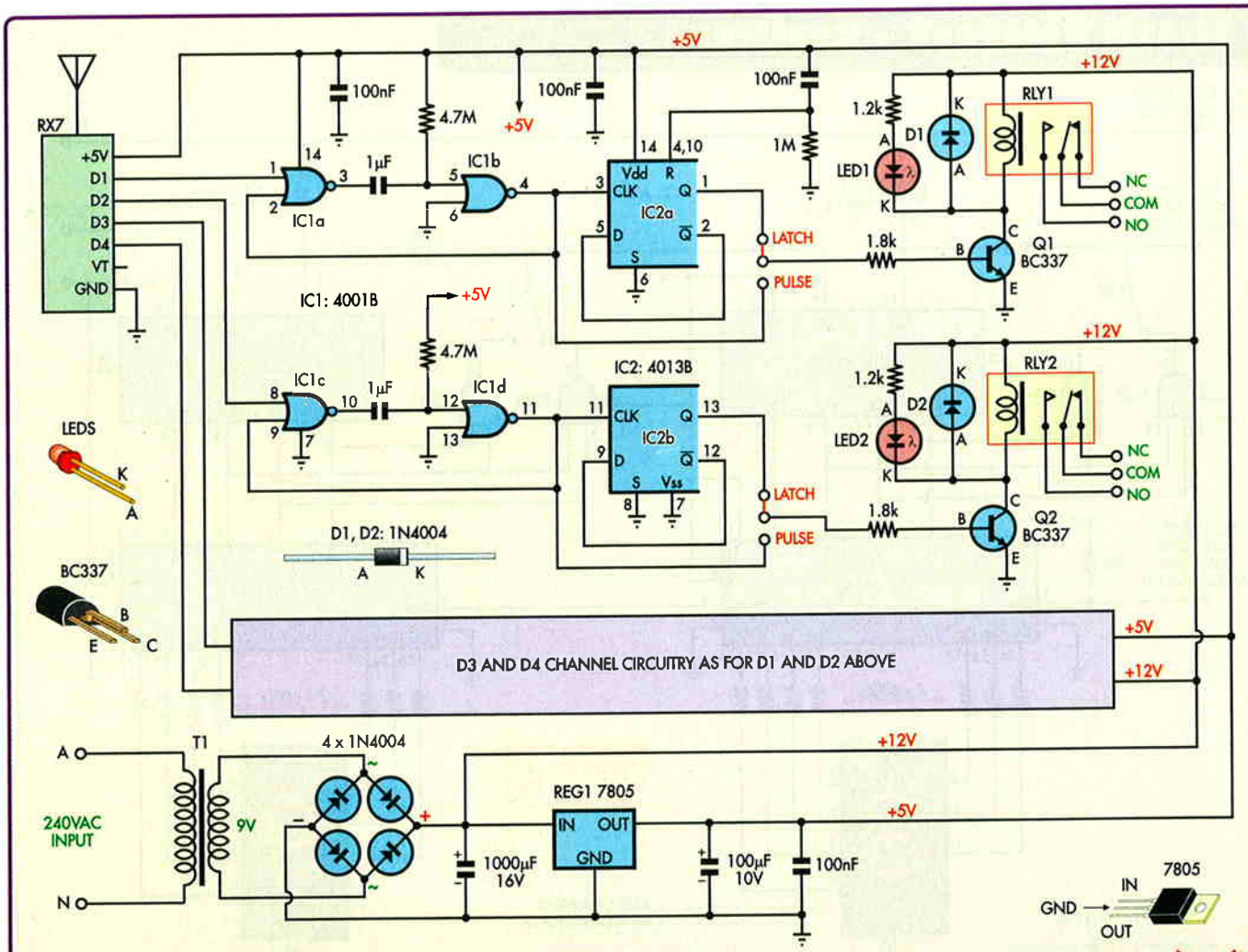
Did your last automotive electronics project behave normally on the bench but go haywire when mounted in your car? Chances are, it was affected by the extremely noisy electrical system in your car.

It's easy to add power supply protection and filtering to low-drain devices. This circuit can power any device rated at 12-14V with a current drain up to about 100mA.

The circuit is based on a simple polarity protection diode (D1) and zener clamp (ZD1), with a 10Ω resistor acting as a current limiter. Together with the two filter capacitors, this simple scheme is remarkably effective at squashing those power-line bugs. In fact, it has been used with success in many SILICON CHIP automotive projects.

For cases where the equipment is portable and attached with flying leads, a polarity indicator can also






## Reliable 4-channel RF switch

This circuit was designed to enable remote switching of mains appliances but is equally applicable to other RF remote control applications. Initially, a 2-channel RF remote control kit from a well-known supplier was chosen for the job. As it turned out, the kit worked well on the bench but when called upon to switch mains loads (via 240VAC relays), it got the "stutters".

Whenever a button on the remote was pressed, the respective relay switched on and off many times, ending randomly in either state. Although the problem appeared to be due to contact bounce in the transmitter's pushbutton switches, this could not be the case because the system worked fine when not switching a load. In addition, the same symptoms were apparent when nearby equipment was manually switched on or off.

Further investigation proved that the problem was due to RF interference from contact arcing. The cure was to interpose a monostable switch with an "on" time of about 4s in each channel, as shown in the above receiver circuit diagram.

4001 NOR gates perform the monostable function in each channel, while 4013 flipflops act as latches. The BC337 transistors (Q1 & Q2) drive 12V relays, which have contacts rated at 250VAC for mains use. Provision has been made for either momentary or latched operation.

The circuit is powered via a Jaycar MM-2002 transformer (using the 8.5V tap) and four 1N4004 diodes wired as a full-wave rectifier. A 12V DC plugpack could also be used. Suitable transmitter and receiver pairs are available from Oatley Electronics (part no. TX7 & RX7) for $11 and $12, respectively – **see www.oatleye.com**

**Jack Holliday,**
**Nathan, Qld.**

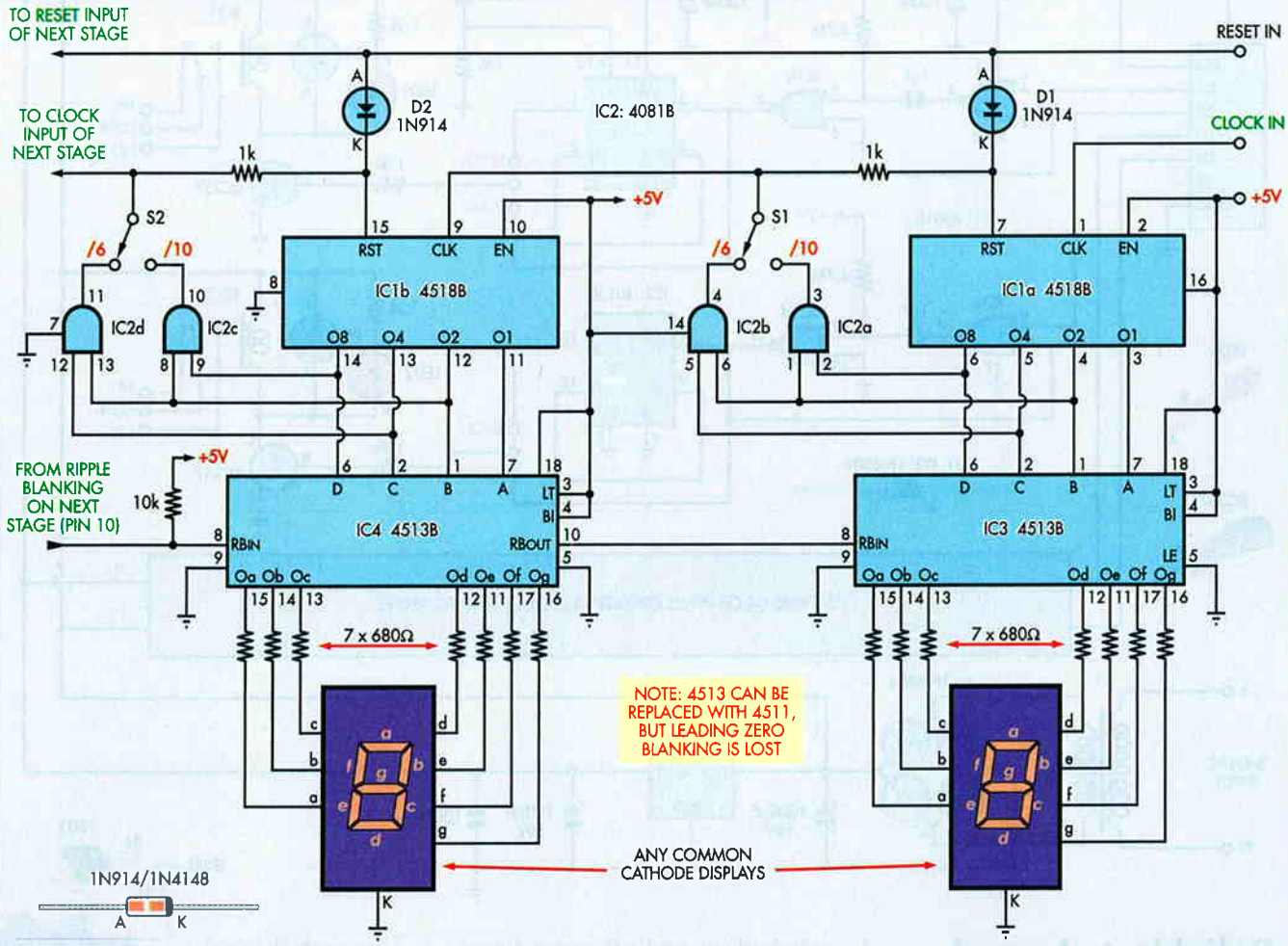
**Jack Holliday is this month's winner of a Peak Atlas Test Instrument**

come in handy. This is achieved with LED1 and the two associated diodes (D2 & D3), together with a 1kΩ limiting resistor.

When the supply leads are connected correctly, the green LED illuminates, whereas when the leads are reversed, the red LED illuminates. As mentioned, diode D1 protects the load from reverse polarity damage.

Finally, the circuit could be made to produce a lower voltage (eg, 5V or 9V) by wiring a suitable 3-terminal regulator in series with the output.

**John Rigon,**
**Deer Park, Vic. ($30)**




## Expandable 2-digit LED counter

This general-purpose counter is very versatile and will suit a variety of applications. It can count in decimal or time and is easily cascaded, allowing you to add as many digits as you like.

As shown, the common-cathode LED displays are driven by 4513 BCD-to-7 segment latch/decoder/driver chips (IC3 & IC4). Unfortunately, these are now obsolete and quite difficult to obtain. A suitable alternative is the 4511, which lacks only the leading zero blanking feature of the 4513.

The counting function is performed by a 4518 dual BCD counter (IC1). Each pulse on the "CLK" input (pin 1) of IC1a advances the count. The BCD outputs (O1-O8) are monitored by two AND gates, such that IC2a's output goes high at a count of 10, while IC2b's output goes high at a count of 6.

Switch S1 is used to select between a decimal (/10) or time (/6) compatible count, as its position determines when counter IC1a is reset. The reset pulse is also used to clock the following stage, based on the second half of the 4518 (IC1b).

The second stage operates in exactly the same way as the first. Additional stages can be cascaded in an identical manner. For example, two complete modules could be used to create a 4-digit counter with a maximum count of 9999 in "decimal" mode, or 59 minutes 59 seconds (with a one-second clock input) in "time" mode.

Add a third module and a complete clock could be built by detecting a 1 or 2 on the most significant digit and a 2 or 4 on the next digit. This way the display can read 12:00:00 or 24:00:00.

Using 4000 series CMOS chips, the maximum clock speed is about 4MHz. If higher speeds are required then functionally equivalent HC series devices could be used.

**Jeff Monegal,**
**North Maclean, Qld. ($50)**

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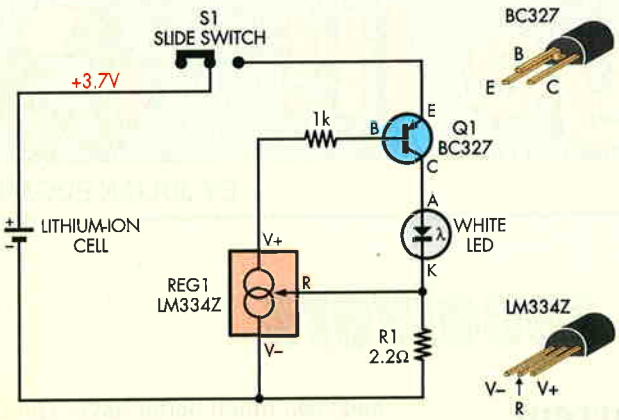
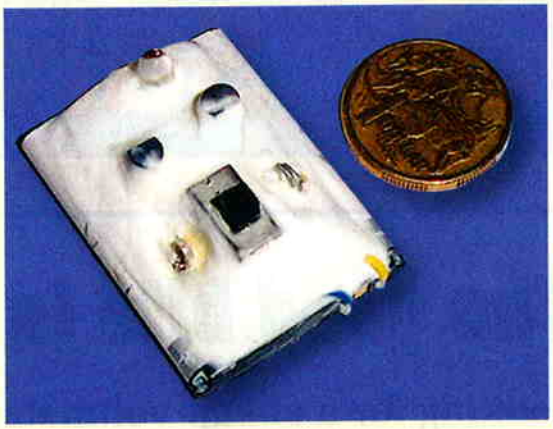


## Cheap, reliable LED torch

This simple LED torch is cheap and easy to build and was found to be very reliable. The use of a 3.7V Li-ion battery together with a low-dropout constant-current regulator also means that it is very efficient. The author's unit powers a single, high-brightness white LED for 30 hours before light intensity begins to drop off.

The constant-current regulator is based around an LM334 current source (REG1). This device is rated at 10mA maximum, hence the need for the transistor (Q1) to boost current handling. The regulator attempts to maintain 64mV between its "R" and "V-" terminals, so the 2.2Ω resistor sets LED current to about 29mA.

Alternatively, if you are happy with just 10mA of LED current (which will give about half the brightness), you will only need the LM334 and the 2.2Ω resistor. The LED then goes in series with the "V+" terminal.

Note that the 1kΩ resistor is needed in the base circuit because without it, the current through the LM334 will increase as the voltage continues to fall and can easily go above the 10mA limit. The value shown limits the LM334 current to about 1.5mA but in practice, its value is not critical as it only comes into play below 3.3V. A lower resistance value will slightly increase brightness but reduce efficiency, whereas a higher value will slightly improve efficiency but reduce brightness.

The circuit could also drive two LEDs in series if operated from a 9V battery. In this case, replace the 1kΩ resistor with a 3.3kΩ value.

The lithium-ion battery can be scrounged from an old mobile phone. After the circuit has been tested, it can be encapsulated in silicone sealant or epoxy resin and mounted on the back of the battery, leaving just the LED, switch and two recharging points exposed.

**Guy Burns,**
**Ulverstone, Tas. ($30)**

## Contribute And Choose Your Prize

As you can see, we pay good money for each of the "Circuit Notebook" items published in SILICON CHIP. But now there are four more reasons to send in your circuit idea. Each month, the best contribution published will entitle the author to choose the prize: an LCR40 LCR meter, a DCA55 Semiconductor Component Analyser, an ESR60 Equivalent Series Resistance Analyser or an SCR100 Thyristor & Triac Analyser, with the compliments of Peak Electronic Design Ltd **www.peakelec.co.uk**

So now you have even more reasons to send that brilliant circuit in. Send it to SILICON CHIP and you could be a winner.

You can either email your idea to silchip@siliconchip.com.au or post it to PO Box 139, Collaroy, NSW 2097.

# Salvage It!

BY JULIAN EDGAR

# The good bits in old receivers

**Looking for a cheap voltmeter or current meter to build into a power supply or some other project? A discarded receiver can often supply the parts required.**

I'll be straight-up with you – most old receivers don't yield a bonanza of goodies. Rather, they're a source of a handful of good bits. Some, like the high-value capacitors from the power supply, can be put aside for later projects while others, like the fuses and machine screws, can find a home in your parts drawers.

Sometimes there are also a few heatsinks worthy of salvaging and at other times the speaker output terminals are useful. But to be honest, many hum-drum receivers aren't worth the salvage effort.

There's one main exception to that rule: if the receiver has an analog centre-tuning meter for FM reception, an analog signal strength meter or a bargraph-style LED power output meter, grab it. Why? – we'll come to that in a moment.

Another thing to look for when checking out old receivers is the rear panel marking for total power consumption. If it's in the hundreds of watts, you're probably dealing with a high-quality design. And that makes it more likely that some of the parts will be worth salvaging.

## Bits and pieces

The Akai receiver pictured here (a model AA-R30 from the early 1980s) had seen much better days. The front panel was corroded and there were several gouges in the panels. The lower panel was also badly dented – probably from when it was thrown on the tip.

I bought it for $5 from the shop associated with the tip but it's the sort of receiver that's often given away at garage sales or put out for kerbside rubbish collections.

Leaving aside the meters and displays for a moment, after spending about half an hour with a pair of side cutters and a Philips-head screwdriver, I ended up with four knobs, four fuses, the nuts and washers from four pots (you know how hard these are to source), three low-voltage bulbs, two 8200µF 40V capacitors and a large folded U-shaped aluminium sheet that was used as a heatsink.

OK, so those parts are not really worth the effort unless you like pulling things apart. But let's go back to the displays – these really are useful as we shall see.

**This Akai unit is typical of 1980s receivers that are now often thrown away. When looking for a worthwhile receiver to salvage, look for the presence of digital and analog meters – they're very useful in lots of applications.**

## LED bargraph display

The output power meter is similar to those used in many receivers and amplifiers of the era. It consists of five LEDs mounted on a PC board that's connected to another small board via a ribbon cable. Importantly, these two boards comprise the whole of the power meter which makes it easy to remove for reuse.

With this type of design, it's also straightforward to identify what wires do what. In fact, before you're too free with the cutters, look closely at where the wires go.

In this case, there were two wire pairs that went from the power meter sub-board to the main board. They comprised almost certainly: (1) power and ground; and (2) the

signal inputs to the display (ie, the signal that causes the LEDs to light in sequence).

It wasn't hard to figure out which was which, as the main board had "Speaker A" and "Speaker B" designations next to the connections for the white and purple wires – so these were the signal inputs. The other pair of wires (yellow/black) were therefore the power supply leads, with black almost certainly the negative (ground) connection.

To verify this, I connected a variable power supply to the supply leads and slowly wound up the voltage. At the same time, I fed a small DC voltage to one of the signal inputs. And it worked, the first LED coming on at 0.9V on the signal input (either Speaker A or Speaker B) and with a 6V supply. Similar LED bargraphs are used in many cassette decks – again they're easy to salvage and hard to kill.

## On-board controls

In the case of the Akai power meter, some on-board controls were also provided.

First, a pushbutton switch changed the display to read either x1 or x0.1 of full scale (which, as it happened, was marked at 38 watts). In addition, each input channel had a pot mounted on the PC board for fine tuning. By adjusting the pots and/or the pushbutton, it was possible to set the full-scale deflection to anything between 3.4V and 18.4V.

Further testing showed that while the response of the five LEDs wasn't perfectly linear, it wasn't far off.

So what good is this display? Well, it's ideal anywhere you need an indication of DC voltage!

## Voltmeter & ammeter

The two analog meters (one for signal strength and the other for tuning) on the old Akai receiver are even more useful. These are both contained in the one housing and are ideal for showing both current flow (positive and negative) and voltage. The application? – anywhere a battery is charged and discharged, as in a solar-powered battery bank or in a low-voltage electric vehicle with regeneration.

The signal-strength meter is easily converted to read a voltage from 3.4V upwards – simply wire a 1MΩ potentiometer in series with it and adjust

**In this case, we've salvaged just the heatsink, some knobs, fuses, screws, pot nuts and washers, some filament bulbs, the power supply capacitors and the dual analog meters.**

### MAKING A VOLTMETER

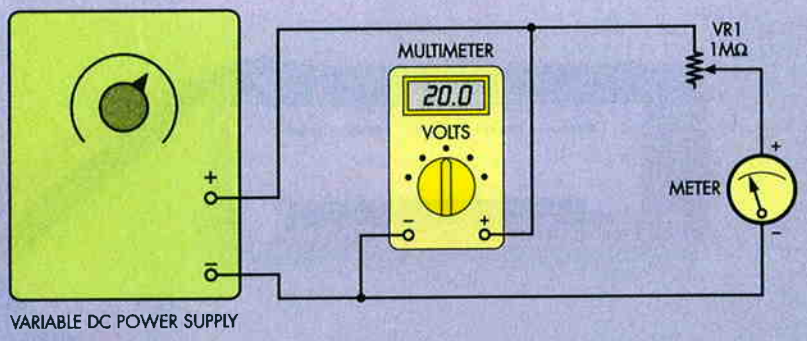



**Fig.1: here's how to recalibrate the signal-strength meter so that it can be used to measure higher voltages. All you need is a 1MΩ potentiometer, a variable power supply and a multimeter. The pot is used to set the full-scale deflection voltage, while the variable supply and multimeter allow the meter to be calibrated.**

### MAKING A CURRENT METER

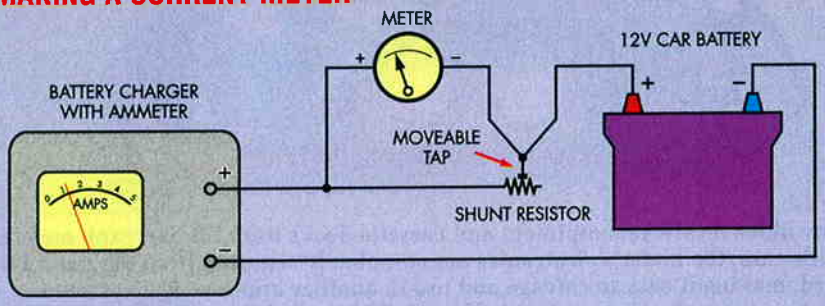
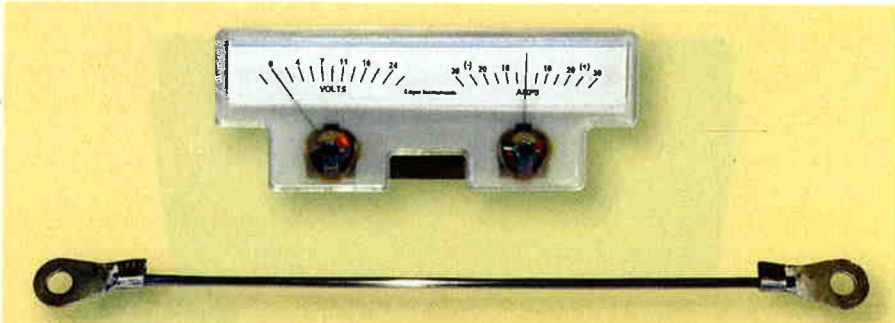



**Fig.2: this circuit shows how to convert and calibrate the tuning meter for use as a current meter. The shunt resistor (easily made from fencing wire) is wired in parallel with the tuning meter and its effective length adjusted until the reading on the meter agrees with the reading on the ammeter.**



**The receiver's signal and tuning meters can easily be adapted to show voltage and current. This photo shows the signal/tuning meter combination equipped with the new scales, while in the foreground is the ammeter shunt, made from a length of salvaged stainless steel rod taken from a discarded garden leaf rake. This set-up is ideal for monitoring a battery bank (eg, in a solar panel installation).**

the pot to give the required full-scale deflection – see Fig.1.

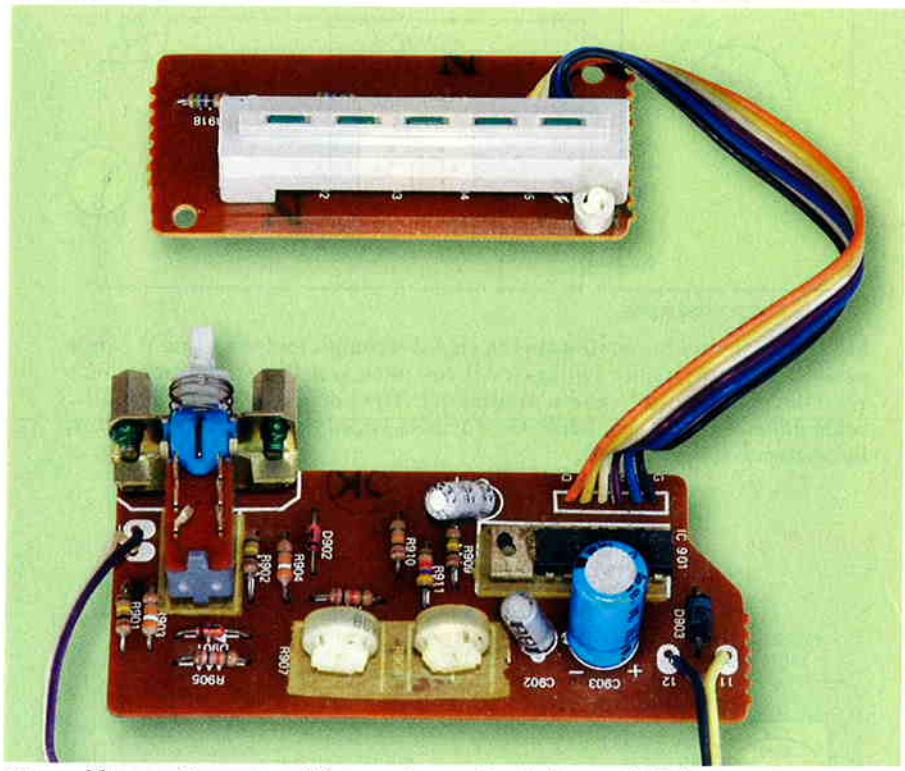
The tuning meter can be converted to a current meter simply by placing a shunt in parallel with it. A shunt is easily made from steel fencing wire or, as I did, from a length of stainless steel rod salvaged from a garden rake!

It's also easy to make new scales for the meters using a PC, scanner and printer – see "Salvage It!" for June 2005. To calibrate the signal-strength voltmeter, you will need a variable power supply. Set the full-scale deflection with the pot and then calibrate the markings against the input voltage as measured by a multimeter (see Fig.1).

Calibrating the ammeter is only slightly more difficult. Fig.2 shows the basic scheme. In this case, a high-powered battery charger (complete with built-in ammeter) was connected to a flat car battery. The shunt was inserted in series between the charger and the battery and the tuning meter (now acting as an ammeter) wired in parallel with the shunt.

By sliding one terminal along the shunt (effectively altering its length and thus its resistance), the reading on the new ammeter can be calibrated to match the battery charger's ammeter. If the battery charger has a 2-position charging switch (ie, to alter the charging rate), it's a good idea to check the meter calibration at the two different charging current values. Alternatively, you can use a current clamp to measure the current flow and then place varying loads on the battery.

So there you are – any salvaged receiver will give you a handful of useful parts. And if you get hold of a receiver with analog or digital meters, it takes relatively little effort to convert the meters for use in a wide range of applications. **SC**



**Many older receivers, amplifiers and cassette decks use LED bargraph meters. In this case, the meter's electronics are completely separate from the main PC board, making it easy to salvage and use in another application. Note how only two pairs of wires connect to the sub PC board at bottom – one pair for the power supply connections and the other pair for signal inputs. This particular circuit also uses two pots and a high/low switch. With these adjustments, it was easy to set the full-scale deflection to anywhere between 3.4V and 18.4V. That makes it a pretty useful voltage meter for use in all sorts of applications.**

## Rat It Before You Chuck It!

Whenever you throw away an old TV (or VCR or washing machine or dishwasher or printer) do you always think that surely there must be some good salvageable components inside? Well, this column is for you! (And it's also for people without a lot of dough.) Each month we'll use bits and pieces sourced from discards, sometimes in mini-projects and other times as an ideas smorgasbord.

And you can contribute as well. If you have a use for specific parts which can easily be salvaged from goods commonly being thrown away, we'd love to hear from you. Perhaps you use the pressure switch from a washing machine to control a pump. Or maybe you salvage the high-quality bearings from VCR heads. Or perhaps you've found how the guts of a cassette player can be easily turned into a metal detector. (Well, we made the last one up but you get the idea . . .)

If you have some practical ideas, write in and tell us!

## ***** NEW KITS *****

### K234 DC PUMP CONTROLLER KIT

This kit will drive our AC pump (PUMP2) (variable up to 400L p/h.) from 12VDC like a battery or solar panel. The PCB has 2 surface mount MOSFETs already fitted, just fit the other parts. Ideal for use with our K009D solar charger & K237 low battery cutout kit. Inc. PCB, all onboard parts. K234: $16. Kit with pump (K234P) $24

### K237 LOW BATTERY VOLTAGE CUTOUT

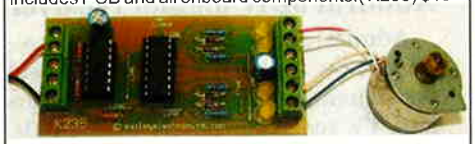
This kit has a number of applications but was designed to disconnect a 12 or 24V battery when the battery voltage drops to a pre-setable limit. Ideal for use with our K009D solar charger & K234 Pump controller. Req. a small amount of fine soldering. Kit inc PCB and all onboard components. (K237) $19

### K009D SOLAR BATTERY CHARGER KIT

This kit is designed to efficiently charge 12V or 24V batteries from solar panels. Simply turns off the charging current when the battery float voltage is reached, & turns on when the battery voltage drops a preset amount below the float voltage. Ideal for use with our K234 pump controller & K237 low battery cutout. Kit is supplied with PCB and all on-board components. ( K009D) $25

### K235 PICSTEP STEPPER MOTOR DRIVER

This simple to build kit uses a SN754410 chip and is designed for use with PICAXE or other microprocessors. Features inc. LED indication. Kit includes PCB and all onboard components. ( K235) $19



### K238 24 WHITE LED 50mm LAMP

This kit has a 50mm diameter PCB and is designed to fit into a downlight fitting. Ideal for use with solar or battery lighting systems Kit includes PCB and all onboard components with 24 X 20,000mCd LEDs. $9

### K242 WITH NEW IMPROVED LONG RANGE 2 CH UHF REMOTE CONTROL RECEIVER WITH 80A LATCHING RELAYS

This kit uses 2 X 80A latching relays that only draw current while changing state. The TX used for this kit is our K190A (not inc. in this kit). with 4 buttons (A, B, C & D). Relay 1 uses button A for ON & B for OFF, Relay 2 uses button C for ON & D for OFF. This type of operation take away the guess work if you can't see or hear what you are turning on or off. Kit inc. PCB and all onboard parts inc. 2 X 80Amp latching relays. (K242) $38

### K142D NEW UNIPOLAR (5/6 WIRE) STEPPER MOTOR DRIVER

This kit is designed to work with our K142 series of kits (see our Website for more details). To get the best performance from this kit it is best used with our K142C constant current driver. The kit contains PCB and all onboard components. (K142D) $27

### HIGH CURRENT RELAY INTERFACE KIT K236

**HIGH VOLTAGE WARNING:**

As this kit involves a dangerous and potentially lethal high voltage, only persons experienced with high voltage wiring techniques should attempt its construction.

This relay based interface kit can switch up to 20A at mains potential, whilst only drawing a few milliamperes from the logic source, such as a microprocessors, digital logic circuits, computers etc. It could be used in various applications such as industrial controls, motors, solenoids, consumer appliances, etc.

The relay used is made by Omron model G7L-1A-P, listed contact rating of 30A, 20A 277VAC(GEN), 20A 120VAC(GEN), 1.5KW 120VAC(XT), 1.5HP 120VAC, 3HP 277VAC.

TV-10 120VAC, 20A 240V~cosf1, 20A 240V~cosf0.4, 20A 120V~cosf0.4.

## 9" FLIP DOWN TFT LCD VIDEO MONITOR

(LCD 9)

These units are brand new current model displays, complete with cabling, remote control and instructions. They are designed to be mounted overhead; under the roof of a car or could be mounted under a shelf or cupboard. For more details see our Website. $220

## 7" TFT LCD VIDEO MONITOR

(LCD7)

These units are brand new current model displays, complete with cabling, mounting bracket/stand, bezel, remote control and instructions. The screen image can be flipped horizontally and vertically for use with reversing cameras. The display can be snapped in or out of the bezel for safe keeping. The bezel can be mounted in to the dash, console, headrest (may require safety approvals) or an other panel in a car or desk etc. $150

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These fans require mains wiring that should only be conducted by a suitably qualified person!

Includes a wiring diagram & starter cap where required. Dim. 190 X 240 X 215mm. Outlet:145 X 90mm. Other fan types also available, see our Website.

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### NEW DOG SILENCER KIT

A new improved high power swept ultrasonic generator kit. It distracts dogs from their "Barking Loop" behavior. Each time the dog barks press the onboard pushbutton or optional remote transmitter button to distract the dog from their "Barking Loop" behavior. The output frequency and sweep rate are adjustable. Unlike previous versions the transformers are fully pre-wound and there is no coil winding to be done. Kit includes PCB, two tweeters and all onboard components. KIT: (K232) $33.

Remote UHF trigger: (k232 $23, Plugpack: (pp15) $10

### COIN HOPPER WITH COIN DISPENSING / COUNTING MECHANISM.

This mechanism was designed as part of a vending machine, it suits $1AU coins. It has a 24V motor & gearbox (all metal gears) & an optical switch to count coins. At 1.8V the motor will start running, it is difficult to stop the output shaft with your fingers at this voltage. The two 8mm gearbox output shafts turn in opposite directions, they have a flat on each & our SPR300 sprocket fits the shaft.

The combination of our SPR300 11 tooth sprocket & our CHAINSP 80 tooth chain and sprocket set would give a slow & powerful output (approx. 15RMP @ 24V or 0.96 RPM @ 2V). This motor & gearbox with chains & sprockets could be used to open doors & gates etc. (see our garage door controller kit K023C).Some approx. voltage/current & RPM figures of the motor/gearbox. 2V 80mA 7RPM, 6V 100mA 30RPM, 12V 120mA 60RPM, 18V 140mA 110RPM, Overall dimensions of the hopper assembly: 93mm(W) X 126mm(L) x 126mm(H).

### K229 AUDIO / VIDEO TRANSMITTER / RECEIVER KIT

(K229TX & K229RX) Now with new upgraded modules for improved range. Designed to transmit & receive video & stereo audio. The TX has been designed to be as small as practical. Construction is simple & the pre-built modules mean minimal work is required & there is no tuning to be done. The antenna can be as simple as a 31mm length of un-shielded stiff wire or another antenna can be connected remotely via co-ax cable. An antenna such as our K198 2.4GHz TX / RX ANTENNA KIT can be added. This antenna kit will increase the range of the K229. The K198 is a 2.4Ghz antenna printed on a circuit board, it has been tested with our previous A/V TX/RX kit and gave good a good image at over 100M.

These kits are designed to operate from a 9VDC supply.

# Vintage Radio

By RODNEY CHAMPNESS, VK3UG

# The Admiral 5BW mantel receiver

**Domestic valve radios with PC boards were relatively uncommon, with most manufacturers sticking to point-to-point wiring until the end of the valve era. One exception to this rule was the Admiral 5BW mantel receiver.**

INSTEAD OF using PC boards, domestic transistor radios were initially built the same way as valve receivers were – ie, with point-to-point wiring. The transistors were also sometimes mounted in sockets, just like valves.

Of course, today we look on such techniques as archaic and totally unsuited to modern technology. Everything is now on PC boards and point-to-point wiring is minimised if not eliminated altogether.

Valve radio receivers were traditionally built using a metal chassis to which all the major components (eg, transformers, valve sockets, tuning gang, etc) were attached. The wiring was all point-to-point which made the assembly slow and expensive.

However, some manufacturers did start using PC boards in valve radios in the late 1950s. We looked at one of these, the Healing 412E, back in February 2001. Admiral, an American firm, also built valve radios with PC boards in Australia but their technique was somewhat different to Healing's.

## Admiral 5BW mantel receiver

Admiral Australia Pty Ltd was located in Gow St, Bankstown, NSW and began manufacturing domestic radios and TV receivers in the mid 1950s. However, they apparently only remained in this field for a few years.

The Admiral 5BW receiver looks much like any other "plastic" mantel receiver of the era. Internally, however, it was different from other receivers in that it used a PC board to mount most of the parts. The only items not mounted on the 100 x 100mm PC board were the ferrite-rod antenna, the combined volume/on-off/tone control,

This is the fully-restored Admiral 5BW in its case. Also shown is the barrel nut that secures the dual volume/tone control assembly.

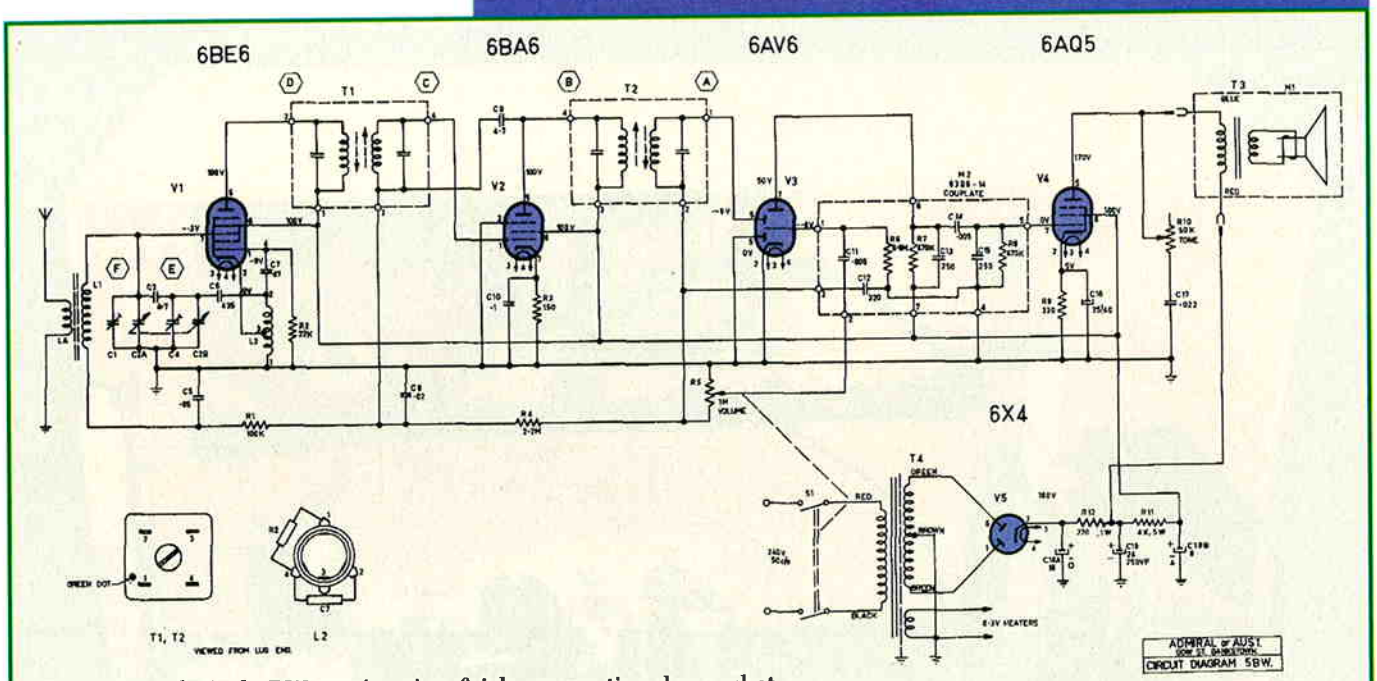



**Fig.1: the Admiral 5BW receiver is a fairly conventional superhet receiver with five valves and a loopstick antenna.**

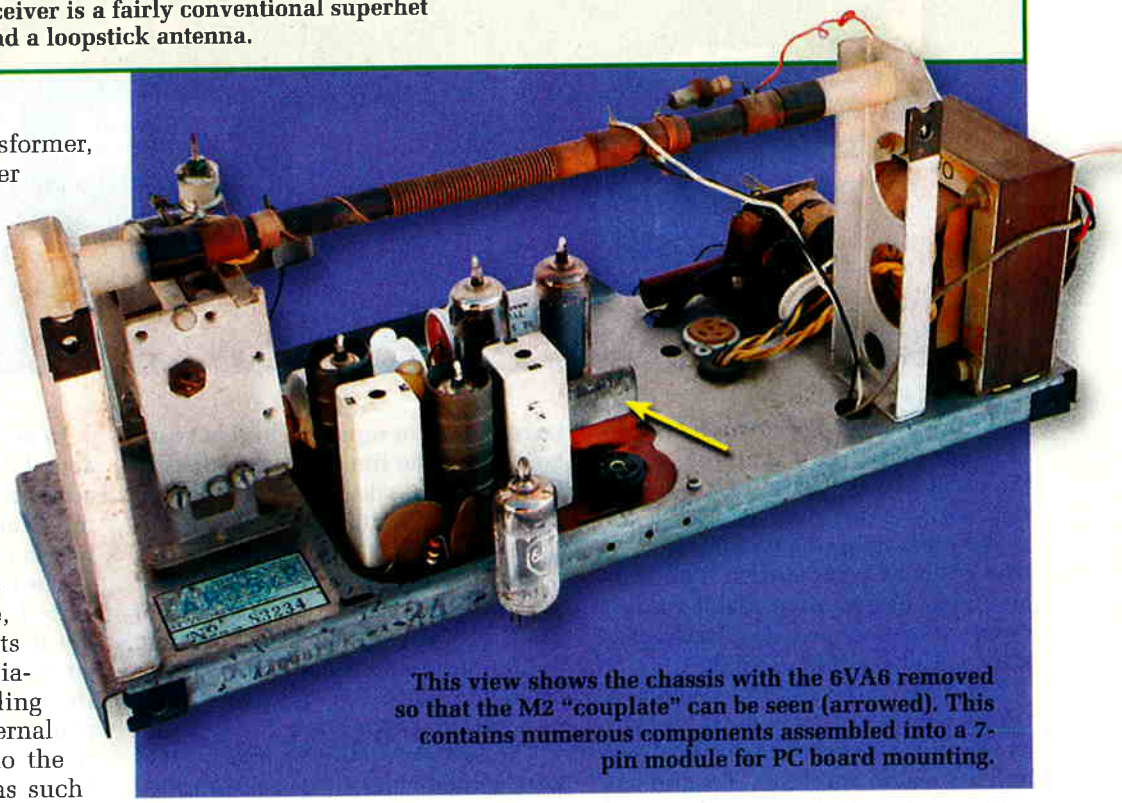
the loudspeaker and its transformer, the tuning gang and the power transformer.

As shown in the photos, the chassis is very sparsely populated except on the PC board. Certainly, if the manufacturer had wanted to, the set could have been made much smaller.

## Circuit details

Although the circuit is conventional, it has a few features that were not commonly used in Australian-designed receivers. For example, the input tuned circuit consists of a 200mm-long x 9mm-diameter ferrite rod with a coupling coil and lead so that an external antenna can be connected to the set. There is no earth lead as such – instead, the set relies on the capacitance between the primary winding of the power transformer and the other windings and the chassis to provide a defacto earth via the mains.

Unfortunately, this isn't the best way to achieve optimum reception, as the mains has electrical noise on it. This noise is coupled into the antenna circuit, giving less than perfect reception in many cases. Additionally, a purpose-made earth ensures that a stronger signal is achieved at the input circuit, as the mains "earth" is not all that efficient.

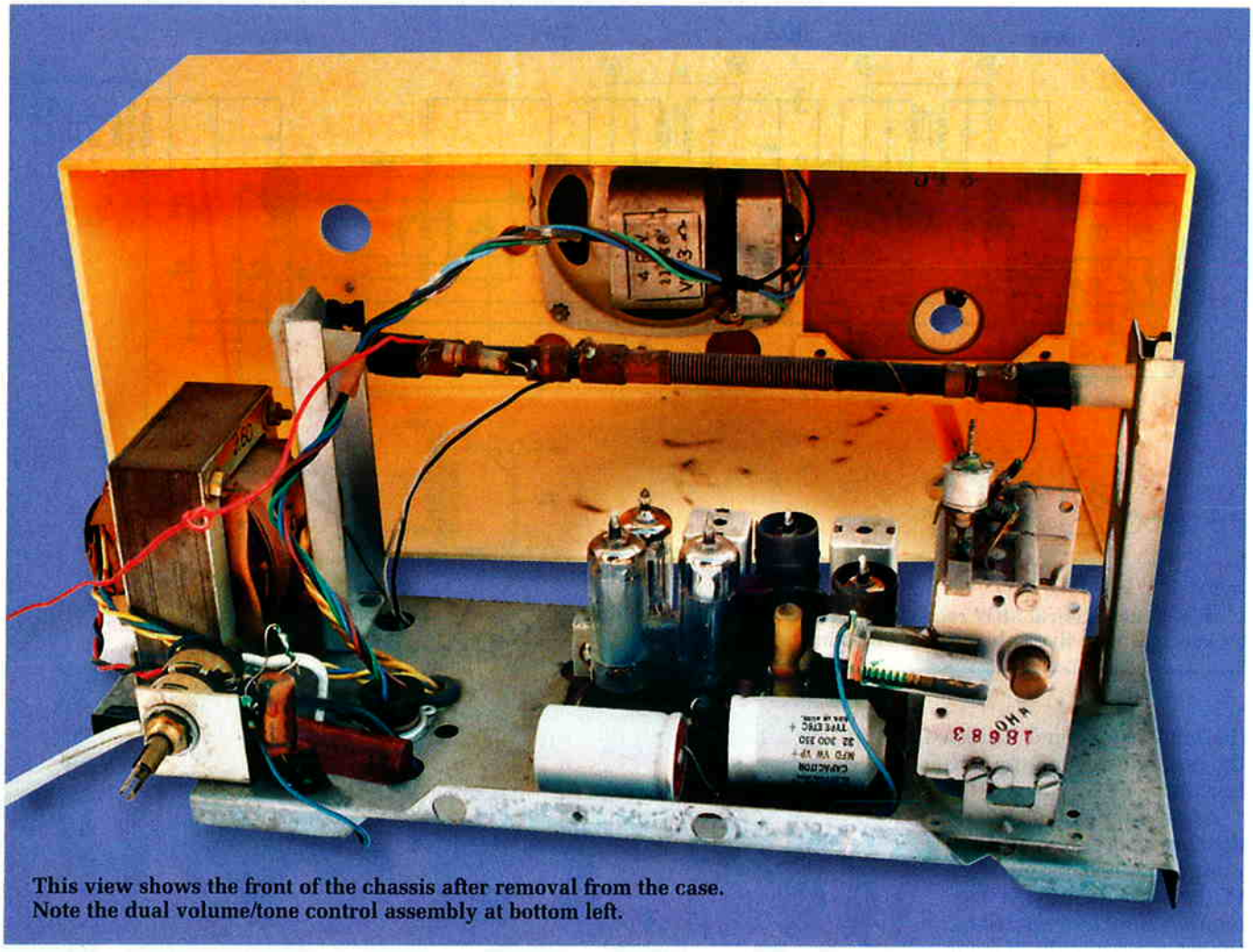


**This view shows the chassis with the 6VA6 removed so that the M2 "couplate" can be seen (arrowed). This contains numerous components assembled into a 7-pin module for PC board mounting.**

The converter stage uses a 6BE6 and is quite conventional, although it has little standing bias and relies on the fact that the high tension (HT) voltage is relatively low. In addition, the set will normally be tuned to a station and hence AGC voltage will be applied.

The tuning range of the receiver is 535-1670kHz which means that it requires some tweaking to reach the lowest frequency on the broadcast band (531kHz). By contrast, at the high-frequency end, it can tune to a number of the special broadcasting services in the 1600-1700kHz subband. The output of the converter is at 455kHz and this is fed to the IF (intermediate frequency) stages.

The 455kHz IF is amplified by a neutralised 6BA6 amplifier and this has cathode bias applied to it in addition to AGC voltage. The neutralising



This view shows the front of the chassis after removal from the case. Note the dual volume/tone control assembly at bottom left.

capacitor is C9 (4.7pF ceramic) which is in a bridge circuit. Another arm of the neutralising circuit is C8 which is the AGC bypass capacitor.

With this neutralising scheme, neither of these components should be altered to the nearest available value if replacement is required, otherwise the stage could oscillate at 455kHz.

The next valve in the line-up is a 6AV6 which serves a multiple role as the diode detector, AGC amplifier and first audio amplifier. The grid has contact potential bias applied to it and the coupling between the plate of the 6AV6 and the following 6AQ5 output valve is conventional.

However, although the 6AV6 circuit is conventional, the way in which it is made is not. Instead of point-to-point wiring, all the parts (including three resistors and five capacitors) are assembled into a 7-pin module that's suitable for PC-board mounting.

The downside to this is that some faults require that the entire module be removed for repairs. This isn't easy because of the limited room adjacent to it on the chassis. This is highlighted by the arrow pointing to the M2 "Couplate" in one of the photographs.

On the other hand, the "Couplates" are fairly reliable. Quite a few of the capacitors in the set are ceramic (which are more reliable than paper capacitors) and the "Couplate" also uses ceramic capacitors.

The audio output stage uses a 6AQ5 with cathode bias. The speaker transformer is mounted on the loudspeaker frame, which in turn is mounted on the front of the cabinet. This assembly is connected via a flying lead and a 4-pin plug into a socket on the chassis.

Note that although the circuit shows only two leads from the transformer, there are in fact four wires in total because of negative feedback from the voice coil. As shown in Fig.1, the cathode of the 6AQ5 is connected via the voice coil to earth and the valve is supplied with back bias.

In fact, the circuit diagram and the actual circuit are different in several areas. However, these differences are minor and should not present a problem to restorers.

The tone control circuit in the plate circuit of the 6AQ5 is poorly thought out in my opinion. The potentiometer is "live" at 200V DC (not the 170V shown on the circuit diagram) which places some strain on its insulation and is also a trap for unwary fingers. If the position of the capacitor and the potentiometer had been transposed in the circuit, there would be no DC voltage on the potentiometer and the whole set-up would have been safer.

## Cleaning the cabinet

The instructions in the service manual for dismantling the set are quite clear although they don't completely cover the set I have. However, the chassis isn't hard to remove. First, the centre piece of the "handspan" dial was unscrewed. The dial then

# Admiral

## SERVICE MANUAL for MANTEL RADIO MODEL 5 BW

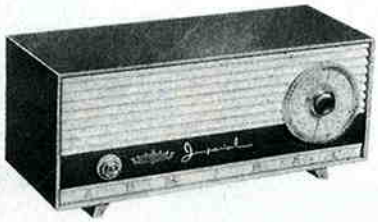


FIG. 1

**COLOUR RANGE**

Red, Cream, Turquoise, Green

**SPECIFICATIONS**

**Circuit.** Superheterodyne receiver with five miniature tubes.

**Frequency Range.** Standard broadcast band, 535 to 1670 Kc/Sec.

**Intermediate Frequency.** 455 Kc/Sec.

**Power Supply.** This receiver operates from the mains supply of 240 volts, 50 cycle alternating current.

**Power Consumption.** Approximately 30 Watts.

**Antenna.** Built in Ferro. Scope Antenna.

**Speaker.** 4in. Permanent Magnet Voice Coil impedance 3 ohms at 400 cps.

**SERVICING THE SET.**

**To Remove Chassis from Cabinet**

1. Gently pull tuning, volume and tone knobs off.
2. Remove dial scale and remove screw located under same.
3. Unscrew nut from volume/tone control bush.
4. Remove plastic cabinet trim and fibre board packing.
5. Remove screw from bottom centre of cabinet front.
6. Chassis with cabinet back attached may now be withdrawn.

To simplify circuit tracing as well as locating and identifying individual circuit components, refer to figure 2.

Figure 2 refers to the foil side of the board and its schematic symbols illustrate what appears in approximately the same position on the reverse side of the board. Use figure 2 together with the schematic for circuit tracing as well as voltage and/or resistance measurements.

Refer to Service Manual No. AS559, available from your Admiral distributor for further general service and repair information of printed circuit wiring.

**PRINTED WIRING BOARD**

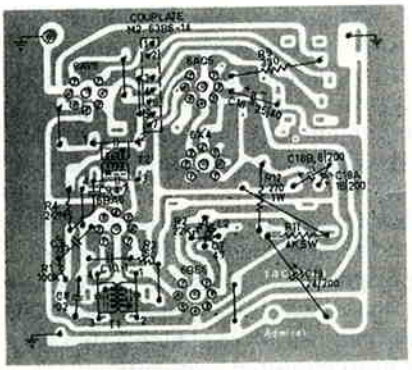


Fig. 2. View of WIRING SIDE of Printed Wiring Board APC27. White area represents printed wiring. Black symbols and lines represent components and connections on opposite side.

**SERVICE MANUAL S13 P/No. A39-21**

**This page from the service manual shows the specifications of Admiral's 5BW. Also shown is some basic servicing information, including the PC board layout.**

came away easily as did the concentric volume and tone control knobs.

That done, the four screws used to secure the back of the cabinet were removed. There were no other screws holding the set in the cabinet but it was still fastened by the volume and tone controls. Closer inspection revealed that these controls are attached to the front panel by a barrel nut over the control shafts. Removing this then allowed the chassis to slide out of the cabinet as far as the speaker leads would allow.

Why do manufacturers leave leads just too short for effective access or maintenance to be carried out? In this case, I wanted to be able to check the set with the chassis out of the cabinet, so I extended the speaker leads.

I had worked on this receiver several years ago, so the cabinet was in reasonable condition and only required a small amount of effort to get rid of any minor blemishes. However, inside the cabinet there are a number of burn marks which are too deep to remove. Just how these burn marks occurred is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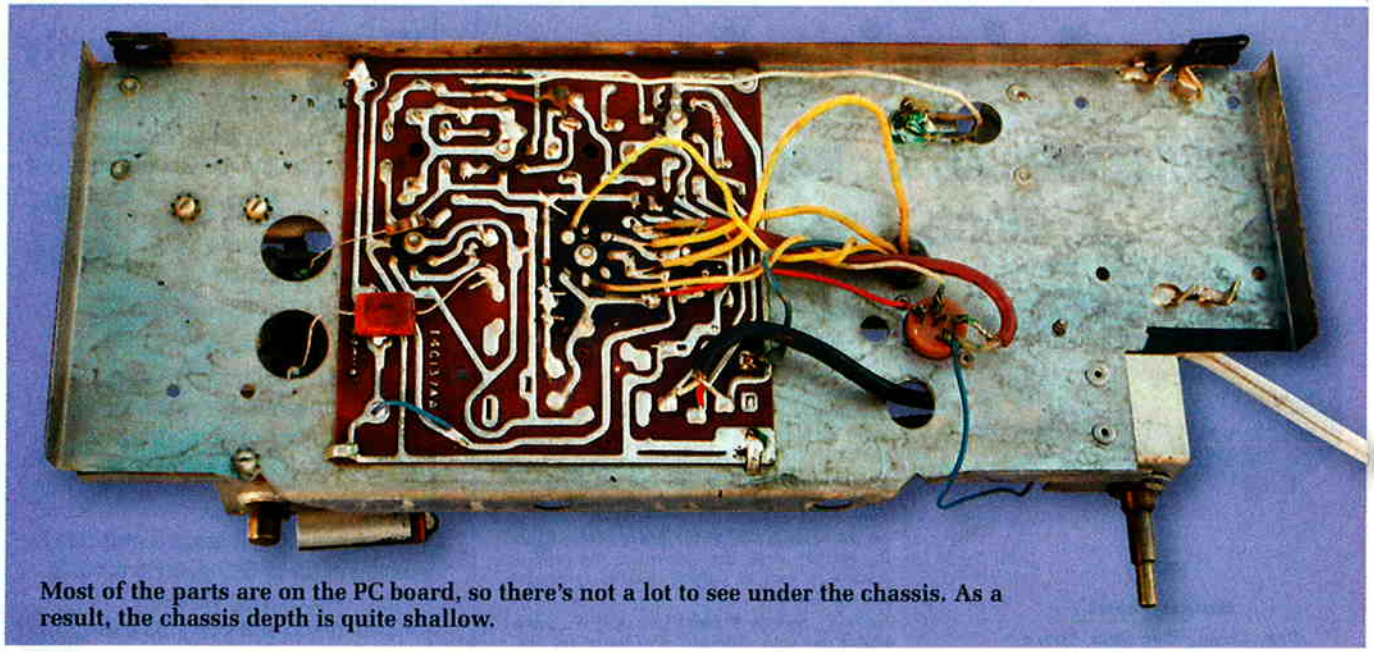

Most of the parts are on the PC board, so there's not a lot to see under the chassis. As a result, the chassis depth is quite shallow.

something of a mystery, as there are no hot components in their vicinity.

## Fixing the faults

As normal, I began by checking the insulation between the chassis and the mains wiring using my 1000V insulation tester. This measured OK, however I also used an earth leakage circuit breaker on the mains as an extra precaution, as this set only had a 2-core power lead fitted during these initial tests. It was later fitted with a 3-core lead, so that the chassis could be earthed (which is much safer).

As stated previously, this set used quite a few ceramic capacitors, particularly in locations were leakage could pose problems. However, I wasn't happy with the leakage of the only paper capacitor on the PC board – a 100nF unit across the 100V line. This was replaced with a polyester type and the set then switched on. As it came on, I made sure that the HT rose to the correct level and that the rectifier wasn't showing any red plates, which would indicate a short or near short on the HT line.

During my previous work on this set, I had cleaned away the muck that had accumulated on the horizontally-mounted PC board. This had been quite difficult to remove due to the crowded nature of the circuit board. It had even effected the components so that they all now looked much the same colour and making it difficult to decipher resistor and capacitor values.

As a result, the new resistors I fitted really do stand out from the dull-looking original components. Of course, the board would not have required anywhere near as much cleaning if it had been mounted vertically.

Anyway, the set had worked quite well when checked over several years ago but its performance had now deteriorated quite markedly. So what had gone wrong with the set? The IF amplifier was now quite regenerative and this had sharpened up the response such that the audio output was quite "bassy".

I began by checking the metal shields fitted to the 6BE6 and the 6BA6 valves as these now appeared quite rusty. As a result, I cleaned the insides of the shields with sandpaper and bent the earthing fingers to ensure a positive connection to each shield. This made little difference, so I then tried another 6BA6 with the result that there was now no output from the set.

The reason wasn't hard to find – its heater wasn't alight. Initially, I thought it must be a dud valve so I substituted another one but the same thing happened. I then refitted the original valve and its and the heater lit up! So what was going on?

The filaments of the two new valves I have substituted were quite OK so I tried closing up the valve socket pins using a small pointed scriber. That fixed the heater problem and the set was also now quite stable when using one of the replacement valves.

Evidently, there is a problem with the original valve that causes the instability but I'm not throwing it out, as it may be quite OK in a different circuit. However, I have marked it as suspect so that I don't get caught out further down the track.

Although the set was now stable, the sensitivity was down and the IF was off tune, with its centre frequency down around 430kHz. As a result, I

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## Photo Gallery: Peter Pan BKM 4-Valve Radio

**MANUFACTURED IN 1948** by Eclipse Radio, South Melbourne, the Peter Pan BKM was a 4-valve reflex superheterodyne housed in a rounded bakelite cabinet that was very modern for the era. This example is housed in the less common green cabinet.

The valve line-up was as follows: 6A8-G frequency changer; 6B8-G reflexed IF amplifier/1st audio amplifier/detector/AVC rectifier; 6V6-GT audio output; and 5Y3-GT rectifier. Photo: Historical Radio Society of Australia, Inc.

tried adjusting the cores to bring it up to 455kHz, which is the correct frequency, and found that I could adjust all but one core which was stuck.

I then tried running some machine oil down the stuck core, after which I was able to adjust it. However, I was still unable to get this core to adjust the tuned circuit to 455kHz and I was beginning to suspect the mica capacitor inside this unit.

Unfortunately, this particular IF transformer is a sealed unit, so I was unable to dismantle it to fix the problem. In the end, I simply replaced it with an IF transformer salvaged from another Admiral chassis. This replacement IF transformer was then adjusted to 455kHz but although the performance was better, it was still not up to scratch.

A quick check of all the RF valves did not reveal any problems, so I decided to take a closer look at the antenna circuit. In particular, I noticed that the antenna coupling coil on the loopstick was quite some distance from the earthy end of the tuned winding. So did it have enough coupling?

To find out, I wound about half a dozen turns of insulated enamelled wire onto the earthy end of the tuned winding and found that this noticeably improved the performance. I am now satisfied that I've got as good a performance from this set as I can reasonably expect.

### Summary

Admiral was one of the first manufacturers to use PC boards and they nearly got everything right with this set. However, with the benefit of hindsight, the PC board could have been mounted vertically and all the fixed capacitors other than electrolytics should have been ceramic types for greater reliability (polyester capacitors weren't readily available at that time).

The set itself is neat and functional and makes a good kitchen mantel receiver. Finally, although my set is cream in colour, it was also available in red, turquoise and green. It is a set worth having in any collection. **SC**

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## Wiring two SC480 modules for stereo

I am building a stereo amplifier using two SC480 amplifier modules (plastic version) and was wondering what is the best way to position the two modules and their associated wiring, so as to minimise interference, distortion and radiated noise.

I am using a single heavy-duty power supply module and a larger transformer. Clearly, both modules need to be more or less next to each other, since they have to be attached to the heatsinks at the rear of the case. This means that the power leads to the module further away from the power supply board have to run past/over/under/around the first module and its audio input leads. (J. S., via email).

● You really have no choice but to put the modules side by side with the output transistors mounted to a common heatsink. You will have more problems with radiation from the power supply than from each module. Keep the power transformer's secondary leads as far away as possible from the input leads to the modules.

## Suppressed zero voltmeter needed

I am having a spot of bother in that I haven't done any electronics for about 20 years and now have the need to nut out a circuit. I have a bank of batteries in my motor home (2 x 6V in series and two sets in parallel giving 12V @ 175Ah) which run a 12V-to-240VAC inverter.

I have reclaimed a 250µA meter from an old cassette recorder and placed a 62kΩ resistor in series with it to give a 0-16V FSD meter. But measuring the batteries gives only about two degrees of deflection between 12V and 14.6V which I am finding hard to observe.

Is there some way I can make a circuit that gives a full scale deflection of 15V but which doesn't kick in until it reaches 10V; ie, reading from only 10V to 15V?

I have thought of using zeners and voltage dividers, etc but as I don't want to blow the guts out of my meter, I thought I'd ask for help. (P. F., via email).

● All you need to do is to put a 10V zener in series with the meter and then calibrate the circuit for full-scale deflection at say, 15V. You will need to adjust the series resistor to achieve this.

The result will be that for voltages below 10V, there will be no pointer deflection on your meter. As the voltage is increased above 10V, the zener diode will conduct and the meter will indicate a linear range up to 15V or whatever you set it to. This is called a "suppressed zero" meter.

## Tacho For 2-Stroke Outboard Motors

I am looking for a portable tachometer/rev counter suitable for 2 & 4-stroke outboards. Your digital tacho (SILICON CHIP, April 2000) as sold by Jaycar (Cat. KC5290) is claimed to do the job.

We have tried other tachometers whose makers claim that they will do the job but upon testing, these claims have proved false. Can you give me an assurance that this kit will, in fact, read revs from 2-stroke outboard motors? (G. G. Taupo, NZ).

● The Digital Tachometer is designed to operate with 2 or 4-stroke engines with up to 12 cylinders.

There are two inputs – a digital input and an ignition coil input. However, with some ignition systems, there is no connection that can be used to trigger the tachometer since there is no digital tacho signal or suitable high-voltage ignition coil signal. That's because some outboard motors use a capacitive discharge ignition with a magneto style trigger and a coil that develops a high voltage via the spinning magneto magnets. This ignition system requires no extra supply and so there is no 12V supply available. However, a 12V supply is required for the tachometer.

Because of this we cannot guarantee that the tachometer will work with all outboard motors. The tachometer will work on outboards that have a 12V supply and that operate with a standard Kettering ignition system.

Some readers have successfully used the tachometer on outboard motors with capacitor discharge ignition by building an optical trigger using a rotating vane and a photo interrupter such as the Jaycar ZD-1901.

## Test circuit for a silicon bilateral switch

How do you test an SBS (silicon bilateral switch)? Do you have a test circuit? (A. W., via email).

● We do not have a test circuit. All you need to test an SBS is a variable DC supply and a 4.7kΩ resistor. At any voltage below its breakover rating, no current will flow through the SBS. When you wind the supply above the breakover rating, the SBS will "break down" to a low voltage with the current limited to a safe value by the 4.7kΩ resistor.

Just connect up the suggested test circuit, wind up the voltage and you will have a graphic demonstration of how an SBS works.

## Energy Meter will not run at 9V

I have just completed the Energy Meter from the July & August 2004 issues of SILICON CHIP and while it

## Battery Zapper Not Suitable For Gel Cell Batteries

I recently built the Deluxe Lead-Acid Battery Zapper & Condition Checker (SILICON CHIP, May 2006) but have the following problems:
(1). The Zapper mode works for 6V, 12V and 24V batteries but the Condition Checker only works on 12V and 24V units. When using the 6V mode, all five of the LEDs light up and remain lit.
(2) When in the 6V position, putting the voltmeter on pins 14 & 1 of IC2 (4093B) shows that the voltage is down below the working voltage of the IC (3-15V). The red high LED (pins 2 & 4) on the logic probe will not light up because the voltage is not high enough. Pins 3 & 5 are lighting up, indicating green on the logic probe.

I purchased this kit to use on SLA Gel Acid batteries (both 6V and 12V) and also lead acid batteries in ride-on mowers and motorbikes. Could you please tell me how to fix these problems? (G. K., via email).

- First of all, you mention that you purchased the kit for use on SLA gel cell batteries. We assume that you will mainly be using the tester to check the condition of these batteries, because it is generally accepted that SLA batteries do not respond to zapping and apparently can sometimes explode if they are connected to a zapper for a significant period of time.

If the condition-checking LEDs remain on when you are trying to check 6V batteries, this may be because pulse oscillator IC2 is not functioning. This in turn may be due to a very low supply voltage for IC2, which would correspond to the very low reading you are apparently getting for the voltage between pins 14 & 7 of that IC. The voltage at pin 1 is not relevant, because this is not a supply voltage pin.

When the circuit is idling, pins 5 & 3 of IC2 should be at logic low while pins 2 & 4 should be at logic high. These two sets of pins only switch to their opposite logic levels briefly after you have pressed S4, the Check button.

It's not easy to suggest what may be causing the very low supply voltage for IC2 and IC3 in the 6V position. We suggest that you check the polarity of all diodes, including ZD4, in case you have fitted one of them with reverse polarity.

seems to work satisfactorily there are a couple of problems. Also, to make the unit more readable in some locations, I have replaced the supplied LCD with one with a LED backlight, with a separate pushbutton to charge a capacitor to drive a transistor to operate the LED for a short period after the button is pressed, rather then drive the backlight all the time (and save the backup battery) when not powered.

I cannot get the meter to zero regardless of OFFSET setting. When mains-powered but with no load connected, the POWER reads between -13.7W and -15.2W with a variety of OFFSET settings from 0 to 150. There appears no correlation between OFFSET parameter and Watts.

Under battery power, the Watts reading does shift with OFFSET as I would expect and a setting of 7 seems to zero the meter successfully. The POWER parameter also works as expected, allowing me to calibrate the meter according to your directions. Watts up?

When I first constructed the meter, I installed a partially charged rechargeable 9V battery and when powered up, the lower line of the LCD was not visible, nor could I get it to restore by cycling power or holding CLEAR to reset the device. This is not the case when the battery was charged (by external charger). I presume its charging current is preventing full voltage on the 5V rail and/or somehow inhibiting the correct initialising of the LCD module on power up.

Is this something I need not be concerned about or is it a symptom of some other problem? (B. G., via email).

- The Energy Meter is not designed to run on a 9V battery as a standard power source. This is because the 9V battery cannot supply sufficient current at start-up.

This is why the LCD does not start up correctly on battery power. It will operate correctly when powered via the mains power supply and then by battery. The battery is there to maintain operation if power goes off.

The zeroing problem is probably due to signal entering via the transformer. In other words, it is coupled in via the transformer laminations. Make sure the metal case is earthed correctly and that the mains leads kept away from the PC board.

## A Studio 350 on steroids

I have a number of questions with regard to the Studio 350 amplifier module described in the January & February 2004 issues.

First, the power supply design shows a massive 6 x 8000µF 80V capacitor bank just for one module. I assume the large capacitor bank is intended so that two modules can be used from the one power supply with the addition of an extra 500VA transformer. I just want to verify with you that this was correct.

I was very interested in modifying the amplifier for more output power. I was interested firstly in the maths behind how you calculated and plotted the power curves for a complex load, so I could do some plots of my own with different speakers. I wanted to increase the number of output devices from eight to 16 so an inductive 2-ohm load can be driven without damage.

The issues, as far as I know, are that the MJE15030/15031 driver transistors probably will not have enough grunt. If I modified the module to have 16 output devices, changed Q8 and Q9 to MJW1302A/MJW3281A and provided the power supply has double the 8000µF filter capacitors and a 1kVA transformer, would 700W of power into a 2-ohm load be achievable at low distortion?

I was also interested in increasing the power rails from 70V to 95V so that 500W was available into a 4-ohm load. If all the filter capacitors were 100V and I increased the number of output devices so the SOA (Safe Operating Area) was not exceeded, including upgrading Q8 and Q9, and Q2 and Q3 (2SA1084 90V) were in-

## Frequency Readout For Radios

(1) The October 2003 frequency counter was a great design but many people would love to be able to use this unit as a digital dial attached to older communications receivers, etc. This would involve IF frequency offsets, both above and below the received frequency.

An obvious and popular choice would be the counter reading 455kHz low. Perhaps you could consider revealing the programming secrets of this design to those of us who have yet to venture into PIC programming. A small amplifier to interface between the counter and RX oscillator would also be a useful addition. (M. K., Jandowae, SA).

(2) I wonder if would be possible to design a small indicator, that when placed next to a radio, would indicate its tuned frequency, maybe via induction with the local oscillator. I have a clock radio that only displays the time – the dial indicator is not illuminated and just about impossible to see with my aging eyes. So, I find myself tuning up and down to try to get a station that I want to listen to. This takes a while as I invariably tune in the wrong direction, then have to wait for a station ID to be broadcast, etc. Anyway, just thought it may be a challenging but useful little project. (G. T., New Farm, Qld).

● Both the above requests are looking for the same solution – ie, frequency readout with an input offset to compensate for the receiver's intermediate frequency. In fact, the approach is to measure the receiver's local oscillator instead of the tuned frequency and then offset the frequency reading by the value of the intermediate frequency.

SILICON CHIP has not produced a project along these lines and we feel that few people would build one if we did. However, a suitable design was published in the October 1982 issue of "Electronics Australia", entitled "Digital Readout for Shortwave Receivers", by John Clarke. That design is still valid although it uses a large number of 4000 series CMOS and 74LS series chips.

We can provide a photocopy of the article for $8.80 including postage.

creased to 2SA1085 (120V devices) and Q1 (BC556) was also upgraded to 2SA1085 due to the higher voltages, will this work? Perhaps my bias current may be a bit high? Can you see any other issues?

Finally, if I went to the trouble of gain-matching Q2 and Q3 and all the output transistors, would it improve THD performance? Would you agree that matching Q2 and Q3 (the long-tail differential input pair) will make a bigger improvement with distortion figures than going to all the trouble of matching the output devices? (B. T., via email).

● The answers to your questions are as follows:

(1). The amount of capacitance used for the supply is about right if the module is to be operated at full power and with low distortion. However, a stereo pair could be driven from the same supply with little perceived reduction in output power.

(2). We assumed a "typical" reactance for our calculations, allowing us to plot single load lines for the 4-ohm and 8-ohm cases. An easier method is to plot the worst case for all reactive loads, which is just a straight line. For the 4-ohm case shown in Fig.1 of the article, this line would extend from the same maximum current point as the 4-ohm resistive plot to a point at twice the rail voltage (ie, 140V). To understand how this works, we recommend a good textbook such as Douglas Self's "Audio Power Amplifier Design Handbook" (see the review on page 65 of this issue).

(3). We cannot recommend that this amplifier be used to drive 2-ohm loads – even with modifications. At best, distortion will be higher due to beta loss in the output stages and at worst, it may be unstable.

(4). Matching will not make a noticeable difference to performance, especially considering that we've provided offset adjustment. Just make sure that the output transistors are genuine On Semiconductor (Motorola) devices.

We described a 500W amplifier in the August, September & October 1997 issues of SILICON CHIP.

## Running a 6V car radio on 12V

I am restoring my 1953 Pontiac convertible here in California. I have converted the car to 12V with a GM alternator and have a perfectly good 6V radio that I want to keep as is.

I was told that if I change the vibrator to a Delco 12V unit, then I can use the radio as is. Is this so? I did not try it but I have the vibrator. I could not find a voltage step-down device to match the current requirements of the radio.

Is this the right fix? (M. S., via email).

● You cannot simply change the vibrator as other parts of the radio circuit work at 6V as well, principally the heaters of the valves. The safest way to run the radio is to use a 12V to 6V regulator. You would need to find out the current requirement first.

## Problem with Deluxe Battery Zapper

I have been struggling to get the Deluxe Battery Zapper (SILICON CHIP, May 2006) to work. In the condition checker side of things, I had to change the value of the two resistors connected to Q7; the 10kΩ to 5.6kΩ and the 4.7kΩ to 22kΩ. This was done to make Q7 function properly (before, it was on all the time). And since there was a high amount of positive voltage at the gates of the Mosfets, why wasn't there a constant high current running through the 0.22Ω resistors?

I can now detect the pulses from Q7 at the gates with my logic probe but my scope is not working properly, so I can't test whether I'm getting a pulse of current across the 0.22Ω resistors. The logic probe detects no pulse at the drain or sources of the Mosfets. I am detecting a battery positive voltage at the sources. Is this normal? Are my Mosfets shot?

On the Zapper side of things, although I have seen a spike on my scope, the meter outputs only reveal the battery voltage. (C. B., via email).

● It should not have been necessary to change the resistor values in the base circuit of Q7. If this transistor was "on" all the time, this must have been due to the output of IC2d being low all the time (instead of high and

low only during the pulses).

This suggests that there is a problem earlier in the pulse generating circuit – ie, around D7-D9, IC3 or IC2, etc. You may have a faulty component or one that is reversed, or perhaps even a solder bridge between pads somewhere in this area.

If you can measure battery voltage at the sources of switching FETs Q3-Q6, this does suggest that one or more of the FETs may have developed a short.

You don't mention what kind of meter you are using to measure the voltage at the "meter" terminals. In order to measure here properly you need to use a DMM, or at least a 20,000 ohms per volt meter, to provide a high-resistance load.

## Touch switch for LED control

I am interested in a low voltage touch-sensing switch to turn on a LED drawing 350mA. Is this possible and if so can you give me details on how do it? (A. P., via email).

● Have a look at the Body Detector in the October 2001 issue and the Proximity Switch circuit in the January 2002 issue.

## Uprating the versatile electronic load

In your March 2006 issue in Circuit Notebook, Jim Rowe contributed a circuit for a Versatile Electronic Load. Is it possible to replace the Mosfet so as to increase the SOA (safe operating area) to 10A at 20-24V or is there another alternative? I'll appreciate very much your help. (R. R., via email).

● If you don't need to use the electronic load at voltages above 100V, substituting an IRF540N device for the STP6NK60Z MOSFET shown in the March 2006 issue will allow it to cope with currents beyond 10A at 20-24V. On the other hand, if you still need to use the unit at voltages up to about 400V, you would need to keep the STP6NK60Z and add a second one connected in parallel with it, on a second heatsink. **SC**

## Notes & Errata

**StarPower Luxeon Star LED Power Supply, May 2004:** several constructors have reported that the sense voltage (set with VR1) could not be adjusted high enough when driving 3W and 5W Stars, resulting in insufficient LED current.

This problem was resolved by replacing the MC34063A switchmode controller IC with an On Semiconductor (Motorola) branded part.

**Smart Card Reader / Programmer, July 2003:** the plastic 3.5-inch to 5.25-inch disk drive adapter shown in the photos is available from PC Case Gear, on the web at **www.pccasegear.com.au** (look in the "Accessories" section) or phone (03) 9584 7266.

**Automatic Daytime Running Lights (Circuit Notebook), August 2006:** on the circuit diagram, transistor Q2 should be identified as a BC327 not a BC337. Also, the resistor in the base circuit of Q1 and resistor R1 should both be 4.7kΩ in value, not 10kΩ as shown.

**Beer 'O' Magic (Circuit Notebook), April 2006:** the 100kΩ resistor from pin 8 of op amp IC1c should connect back to pin 10, not to the positive rail. Also, despite the editor's comments, a triangle wave generator should work satisfactorily in this "experimental" circuit. However, for those that would like to try the sawtooth alternative, a 555 timer based alternative is presented here (Fig.1).

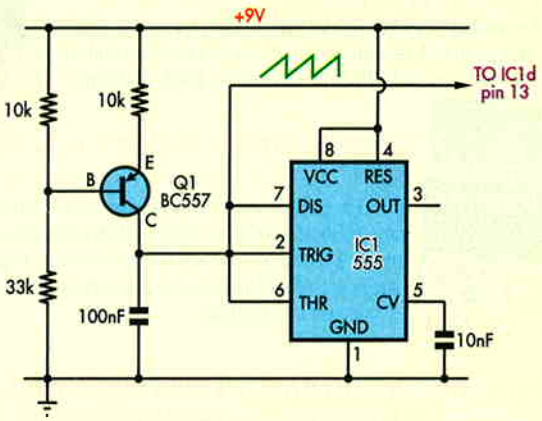


**Fig.1: this sawtooth waveform generator can be used with the Beer 'O' Magic circuit.**

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Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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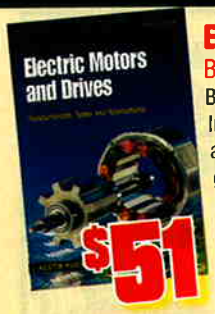


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